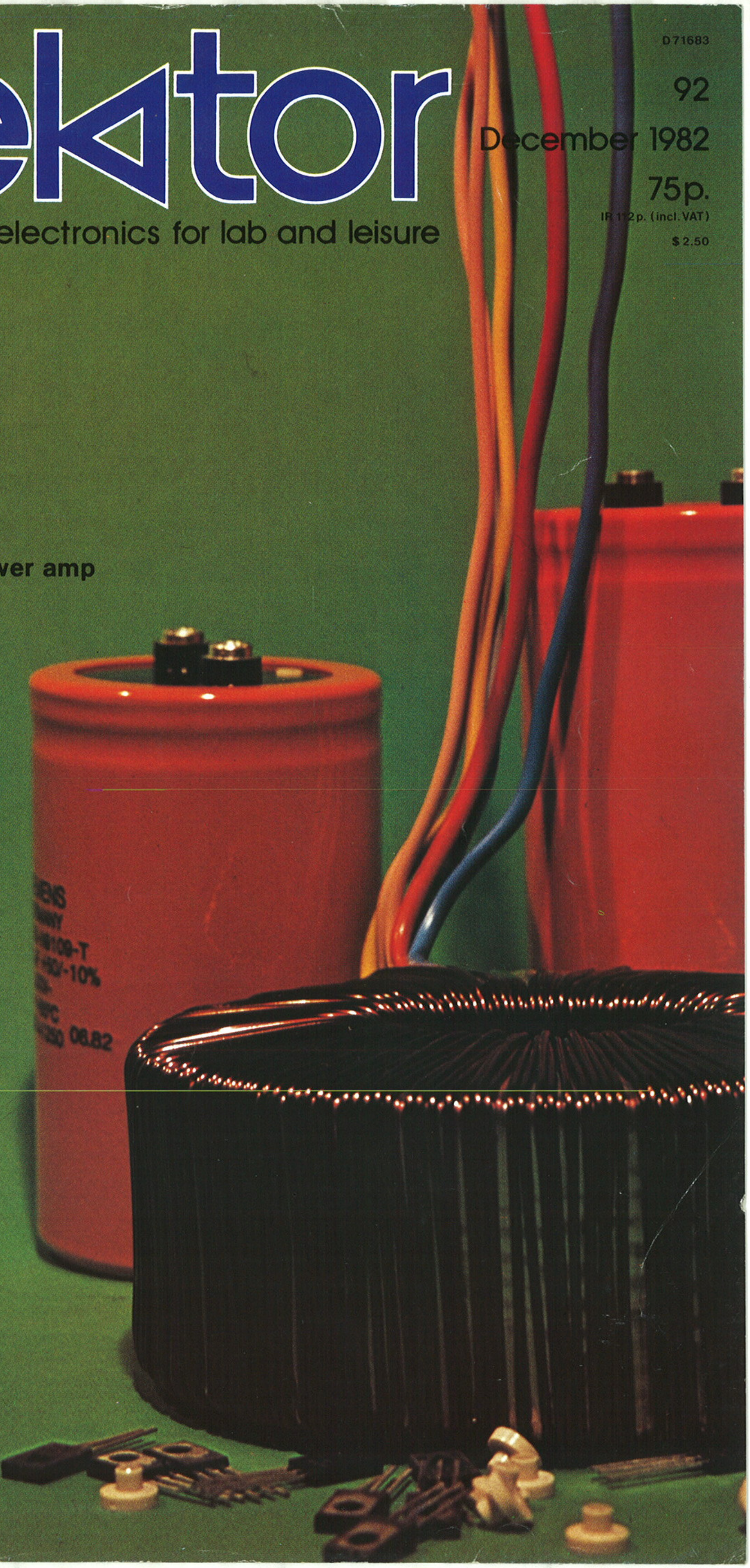
D71683
92
December 1982
75p.
IR 112p. (incl. VAT)
$2.50

elektor

up-to-date electronics for lab and leisure



crescendo:
2×140watt mosfet power amp

the power supply:
0 to 30 volts, 3 amps

triopodus electrus diclopus:
a phototropic whatsit

ioniser:
7 kV off 12 volts

TTLs

Type	Price
7400	11p
7401	11p
7402	11p
7403	12p
7404	12p
7405	15p
7406	18p
7407	18p
7408	14p
7409	14p
7410	14p
7411	16p
7412	14p
7413	16p
7414	18p
7416	18p
7417	18p
7420	14p
7421	18p
7422	20p
7423	18p
7425	18p
7426	18p
7427	18p
7428	18p
7430	14p
7432	18p
7433	22p
7437	22p
7438	22p
7439	25p
7440	15p
7441	55p
7442A	30p
7443	70p
7444	70p
7445	50p
7446A	50p
7447A	36p
7448	45p
7450	15p
7451	15p
7453	15p
7454	15p
7460	15p
7470	30p
7472	25p
7473	25p
7474	18p
7475	22p
7476	25p
7480	48p
7481	120p
7482	65p
7483A	38p
7484	65p
7485	60p
7486	18p
7489	170p
7490A	20p
7491	35p
7492A	25p
7493A	24p
7494	35p
7495A	35p
7496	35p
7497	90p
74100	80p
74104	50p
74105	55p
74107	22p
74109	25p
74110	30p
74111	55p
74112	170p
74116	50p
74118	55p
74119	60p
74120	60p
74121	25p
74122	30p
74123	36p
74125	30p
74126	30p
74128	36p
74132	30p
74136	28p
74141	55p
74142	175p
74143	200p
74144	200p
74145	40p
74147	75p
74148	60p
74150	50p
74151A	36p
74153	36p
74154	50p
74155	40p
74156	36p
74157	30p
74159	75p
74160	40p
74161	40p
74162	40p
74163	40p
74164	45p
74165	45p
74166	48p
74167	150p
74170	120p
74172	250p
74173	50p
74174	55p
74175	50p
74176	40p
74177	45p
74178	70p
74180	40p
74181	115p
74182	40p
74184	90p
74185A	90p
74186	470p
74188	250p
74190	45p
74191	45p
74192	45p
74193	45p
74194	40p
74195	40p
74196	40p
74197	40p
74198	80p
74199	80p
74221	55p
74251	45p
74259	100p
74265	45p
74278	140p
74279	40p
74283	50p
74284	160p
74285	160p
74290	75p
74293	80p
74298	100p
74365A	30p
74366A	30p
74367A	30p
74368A	30p
74390	75p
74393	90p
74490	95p

74LS SERIES

Type	Price
74LS00	11p
74LS02	11p
74LS03	12p
74LS04	12p
74LS05	12p
74LS08	12p
74LS09	12p
74LS10	13p
74LS11	13p
74LS12	13p
74LS13	20p
74LS14	25p
74LS15	12p
74LS20	13p
74LS21	13p
74LS27	13p
74LS30	13p
74LS32	13p
74LS33	14p
74LS37	14p
74LS38	14p
74LS42	30p
74LS47	36p
74LS51	14p
74LS55	15p
74LS73	18p
74LS74	16p
74LS75	18p
74LS76	18p
74LS83	38p
74LS85	45p
74LS86	16p
74LS90	22p
74LS92	30p
74LS93	22p
74LS96	50p
74LS107	20p
74LS109	27p
74LS112	20p
74LS113	20p
74LS114	22p
74LS122	25p
74LS123	34p
74LS124	90p
74LS125A	24p
74LS126A	25p
74LS132	34p
74LS133	25p
74LS136	25p
74LS138	27p
74LS139	27p
74LS145	70p
74LS147	100p
74LS148	75p
74LS151	40p
74LS153	40p
74LS154	80p
74LS155	30p
74LS156	36p
74LS157	27p
74LS158	30p
74LS160A	36p
74LS161A	36p
74LS162A	36p
74LS163A	36p
74LS164	40p
74LS165A	50p
74LS166A	60p
74LS170	70p
74LS173A	55p
74LS174	40p
74LS175	40p
74LS181	90p
74LS190	36p
74LS191	36p
74LS192	36p
74LS193	36p
74LS194A	35p
74LS195A	35p
74LS196	45p
74LS197	45p
74LS221	50p
74LS240	55p
74LS241	55p
74LS242	55p
74LS243	55p
74LS244	55p
74LS245	75p
74LS247	70p
74LS248	55p
74LS249	55p
74LS251	30p
74LS253	30p
74LS257	30p
74LS258	35p
74LS259	55p
74LS266	20p
74LS273	55p
74LS279	30p
74LS283	40p
74LS293	40p
74LS299	180p
74LS323	160p
74LS324	150p
74LS348	90p
74LS352	60p
74LS353	60p
74LS363	140p
74LS364	140p
74LS365A	30p
74LS367A	30p
74LS368A	30p
74LS373	55p
74LS374	55p
74LS375	45p
74LS377	70p
74LS378	70p
74LS390	45p
74LS393	45p
74LS399	160p
74LS445	100p
74LS540	90p
74LS541	80p
74LS610	£19
74LS640	100p
74LS641	100p
74LS642	100p
74LS643	100p
74LS644	100p
74LS668	100p
74LS669	100p
74LS670	120p
74LS682	300p
74LS684	300p

4000 CMOS

Type	Price
4000	10p
4001	10p
4002	12p
4006	50p
4007	14p
4008	36p
4009	24p
4010	24p
4011	11p
4012	16p
4013	20p
4014	48p
4015	40p
4016	20p
4017	32p
4018	45p
4019	25p
4020	48p
4021	40p
4022	45p
4023	13p
4024	32p
4025	13p
4026	80p
4027	20p
4028	40p
4029	45p
4030	15p
4031	125p
4033	125p
4034	140p
4035	45p
4036	275p
4037	110p
4038	110p
4039	290p
4040	40p
4041	40p
4042	40p
4043	40p
4044	40p
4045	105p
4046	50p
4047	45p
4048	50p
4049	24p
4050	24p
4051	45p
4052	60p
4053	50p
4054	90p
4055	90p
4056	90p
4059	450p
4060	55p
4063	90p
4066	27p
4067	225p
4068	14p
4069	14p
4070	14p
4071	14p
4072	14p
4073	14p
4075	14p
4076	48p
4077	16p
4081	14p
4082	15p
4086	40p
4089	125p
4093	24p
4094	90p
4095	75p
4096	70p
4097	290p
4098	90p
4099	100p
40100	200p
40101	130p
40102	140p
40103	170p
40104	90p
40105	110p
40106	36p
40107	60p
40108	450p
40109	100p
40110	275p
40114	225p
40257	160p
4502	60p
4503	45p
4507	35p
4508	130p
4510	45p
4511	45p
4512	48p
4514	110p
4515	110p
4516	55p
4518	40p
4519	30p
4520	50p
4521	90p
4526	60p
4527	60p
4528	50p
4531	125p
4532	70p
4534	400p
4536	270p
4538	90p
4539	70p
4541	70p
4543	75p
4553	245p
4555	35p
4556	35p
4557	300p
4560	120p
4566	160p
4568	250p
4569	170p
4572	30p
4583	90p
4584	36p
4585	75p
4599	290p
4724	150p
40014	40p
40085	90p
40097	45p
14411	675p
14412	800p
14433	1100p
14495	300p
14500	575p
14599	290p
CD22100	350p
CD22101	700p
CD22102	700p

COUNTERS

Type	Price
74C925	400p
74C928	600p
ICM7216B	2000p
ICM7217A	850p
MK50398N	750p
ZN1040E	670p

TTL & ECL

Type	Price
10116	70p
10231	350p

LINEAR I.Cs

Type	Price	Type	Price
AY1-0212	600p	MFID	250p
AY1-5050	99p	MK50398	750p
AY3-8910	380p	ML920	800p
AY3-8912	625p	MM57160	620p
AY5-4007D	600p	NE531	140p
CA3019	80p	NE555	16p
CA3028A	120p	NE556	45p
CA3046	70p	NE564	420p
CA3080E	70p	NE565	120p
CA3086	48p	NE566	155p
CA3089E	200p	NE567	140p
CA3090AQ	375p	NE571	400p
CA3130E	90p	NE5534A	250p
CA3140E	40p	RC4136	60p
CA3160E	100p	RC4151	200p
CA3161E	150p	S566B	225p
CA3162E	450p	SAA1900	£16
CA3189E	300p	SAD1024A	900p
DAC1408-8	200p	SFF96364	800p
HA1388	250p	SL490	350p
ICL7106	700p	SN76477	450p
ICL8038	300p	SP8515	750p
LF351	48p	TA7205	90p
LF356P	95p	TAA550	50p
LM10C	325p	TAA621	275p
LM301A	25p	TBA641AX1	300p
LM310	120p	TBA641BX1	400p
LM311	70p	TBA641B	300p
LM318	150p	TBA651	200p
LM319	215p	TBA800	80p
LM324	30p	TBA810	100p
LM339	50p	TBA820	80p
LM348	65p	TBA950	225p
LM358P	60p	TC9109	750p
LM377	175p	TCA210	350p
LM380	75p	TCA220	350p
LM381AN	180p	TCA940	175p
LM386	90p	TDA1004A	300p
LM387	120p	TDA1008	320p
LM389	95p	TDA1010	200p
LM393	100p	TDA1022	500p
LM394CH	300p	TDA1024	120p
LM709	36p	TDA1034B	250p
LM710	50p	TDA1170	300p
LM711	70p	TDA2002V	325p
LM733	60p	TDA2020	320p
LM741	18p	TLO71/81	25p
LM747	70p	TLO72/82	45p
LM748	35p	TLO74	100p
LM1886	700p	TLO83	75p
LM1889	350p	TLO84	90p
LM2917	200p	TLO94	200p
LM3900	50p	TL170	50p
LM3909	85p	UAA170	170p
LM3911	125p	ULN2003	108p
LM3914	200p	XR2206	300p
LM3915	200p	ZN414	80p
LM3916	225p	ZN419C	190p
LM13600	110p	ZN424E	130p
MB3712	200p	ZN425E	340p
MC1310P	150p	ZN426E	300p
MC1458	36p	ZN427E	590p
MC1495L	350p	ZN428E	400p
MC1496	70p	ZN1034E	200p
MC3340P	120p	ZN1040E	670p
MC3401	50p	ZNA234	850p
MC3403	65p	ZNA134	£23

CPU's

Type	Price
1802CE	650p
2650A	1200p
6502	350p
6800	225p
6802	250p
6809	650p
INS8060	1100p
8080A	250p
8085A	450p
8088	£18
Z80	290p
Z80A	320p
Z80B	£12

SUPPORT DEVICES

Type	Price
3242	800p
6522	310p
6532	550p
6551	650p
6821	100p
6850	110p
6852	250p
8205	225p
8212	110p
8216	100p
8224	200p
8228	220p
8251	250p
8253	390p
8255	250p
8257	400p
8259	400p
8271	£36
8279	440p
Z80P10	250p
Z80AP10	280p
Z80CTC	250p
Z80SIO 1/2/3	£9

MEMORIES

Type	Price
2101-4L	400p
2102-2L	120p
2107B	500p
2111-4L	300p
2112	300p
2114L	90p
2114L-2	95p
4027	300p
4116L-2	90p
4118	400p
4164	550p
4816AP-3	280p
5101L	300p
6116P-3	420p
6116LP-3	550p
6514	250p
6810	120p

PROMS

Type	Price
71301	700p
74S188	275p
74S201	350p
74S287	350p
74S387	350p
74S470	600p
74S471	600p
74S571	650p
74S573	900p
82S123	300p
82S137	750p
93427	400p
93436	650p
93446	650p
93448	900p

BAUD RATE GENERATOR

Type	Price
COM8116	700p
MC14411	675p

EPROMS

Type	Price
2516	250p
2564	£12
2708	250p
2716	250p
2532	375p
2732	450p
2716 300nS	500p
2732 300nS	750p
2764	£11

UARTS

Type	Price
AY-5-1013P	300p
AY-5-1015P	300p
IM6402	450p
TR1602	300p
COM 8017	300p

CHARACTER GEN.

Type	Price
RO-3-2513U.C.	750p
RO-3-2513L.C.	700p
SN74S262AN	£10

CRT CONTROLLER

Type	Price
CRT 5027	£18
CRT 5037	£18
CRT 6545	900p
MC6845	650p
MC6847	£10
SFF96364	£8
9365	£48
EF9366	£48
TMS9927	£18

KEYBOARD ENCODER

Type	Price
AY-5-2376	700p
74C 922N	420p

CRYSTALS

Type	Price
100KHz	250p
200KHz	280p
1MHz	290p
1.008MHz	275p
1.843MHz	210p
2.0MHz	225p
2.457MHz	210p
3.276MHz	150p
3.57945MHz	100p
4.0MHz	150p
4.19MHz	200p
4.43MHz	110p
5.068 MHz	200p
6.0MHz	150p
7.0MHz	150p
8.0MHz	175p
8.867MHz	175p
10.7MHz	150p
15.0MHz	200p
18MHz	200p
24.00 MHz	200p
26.690MHz	150p
27.145MHz	200p

MODULATORS

Type	Price
6MHz UHF	375p
8MHz UHF	450p

TELETEXT DECODER

Type	Price
SAA5020	£6
SAA5030	£9
SAA5041	£16
SAA5050	£9
EF9340	700p
EF9341	700p

INTERFACE ICS

Type	Price
AD558	775p
AD561J	£20
DM8131	275p
DP8304	250p
DS8835	200p
DS8836	150p
DS8838	225p
MC1488	55p
MC1489	55p
MC3446	300p
MC3480	850p
MC3486	500p
MC3487	300p
75107	90p
75110	90p
75150P	120p
75154	140p
75182	90p
75324	375p
75361	150p
75363	150p
75365	150p
75451/2	72p
75491/2	65p
8T26	120p
8T28	120p
8T95/96	90p
8T97/98	90p
9601	220p
9602	220p
9637AP	160p
ZN425E-8	350p
ZN426E-8	350p
ZN427E-8	600p
ZN428E-8	500p

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	18p	28 pin	26p
16 pin	11p	22 pin	22p	40 pin	30p

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

JUMPER LEADS

24'' Ribbon cable with DIP Headers

	14 pin	16 pin	24 pin	40 pin
Single End	145p	165p	240p	380p
Double End	210p	230p	345p	540p

24'' Ribbon cable with sockets

	20 pin	26 pin	34 pin	40 pin
Single End	160p	210p	270p	340p
Double End	290p	385p	490p	540p

24'' Ribbon cable with edge conn.

	20 way	34 way	40 way	50 way
Single End	275p	525p	600p	650p

24'' Cable with 25 way D Connector
Male 500p Female 540p

IDC CONNECTORS

	10 way	20 way	26 way	34 way	40 way
Header Plug	90p	150p	200p	240p	270p
Receptacle	90p	165p	200p	240p	270p
Edge Conn.	200p	250p	320p	380p	560p

EURO CONNECTORS

		Plug	Socket
DIN 41612	2 × 32-way	300p	350p
angled	2 × 32-way	350p	400p
angled	3 × 32-way	400p	—
(for 2 × 32 way specify a + b or a + c)			
DIN 41617	31-way	200p	200p

MIN. D CONNECTORS

	9 way	15 way	25 way	37 way
MALE				
solder	95p	135p	200p	280p
angled	160p	230p	265p	425p
FEMALE				
solder	125p	190p	245p	375p
angled	175p	240p	310p	500p
hood (top/side entry)	100p	100p	100p	150p

25 way Centronix Type Conn. £6.50
37 way Centronix Type conn. £6.50

VOLTAGE REGULATORS
Fixed Plastic TO-220

1A	+ve		−ve	
5v	7805	40p	7905	45p
6v	7806	40p	7906	45p
8v	7808	40p	7908	45p
12v	7812	40p	7912	45p
15v	7815	40p	7915	45p
18v	7818	40p	7918	45p
24v	7824	40p	7924	45p

100mA +ve		TO-92		
5v	78L05	30p	79L05	50p
12v	78L12	30p	79L12	50p
15v	78L15	50p	79L15	50p

OTHER REGULATORS

Type	Price	Type	Price
LM309K	140p		
LM317T	200p	78MGT2C	140p
LM323K	450p	79GUIC	225p
LM723	30p	79HGKC	650p
78GUIC	200p	78PO5	900p
78HO5	550p	RC4195NB	150p
78HGKC	600p	TL497	300p

OPTO-ELECTRONICS

Type	Price	Type	Price
2N5777	40p	ORP60	120p
OCP71	250p	ORP61	120p
ORP12	90p	TIL78	55p
TIL32	55p		

OPTO-ISOLATORS

Type	Price	Type	Price
ILD74	130p	TIL111	70p
MCT6	160p	TIL112	70p
MOC3020	150p	TIL116	70p
MSC2400	190p		

LEDS

0.125''		0.2''	
TIL220 Red	10p	TIL209 Red	10p
TIL222 Gr	12p	TIL212 Ye	15p
TIL228 Ye	15p	TIL211 Gr	12p
Rectangular		LEDS (R, G, Y)	30p

DISPLAYS

Type	Price	Type	Price
DL 704	140p	NSB5881	570p
DL 707 Red	140p	TIL311	600p
DL 707 Gr	140p	TIL312/3	110p
DL 747 Red	225p	TIL321/2	130p
DL 747 Gr	225p	TIL330	140p
FND357	120p	7750/60	200p
FND500	90p	BARGRAPH	225p
FND507	90p	**DRIVERS**	
MAN3640	200p	9368	250p
MAN4640	200p	9370	300p
MAN6610	200p	UDN6118	320p
		UDN6184	320p

★ SPECIAL OFFER ★

2114L	80p	4116–2	80p
2716 (+5V)	250p	4164–2	450p
2532	350p	6116P–3	350p

TRANSISTORS

Type	Price
BC107/8	14p
BC108/9	15p
BC109/C	16p
BC140	30p
BC141	30p
BC160	30p
BC161	30p
BC177	16p
BC179C	18p
BC182/L	10p
BC183/L	10p
BC184/L	10p
BC212/L	12p
BC213/L	11p
BC214/L	10p
BC327	10p
BC337	10p
BC338	15p
BC477	30p
BC516/7	36p
BC547B	12p
BC548C	9p
BC549C	12p
BC557B	12p
BC558B	12p
BC559C	16p
BCY71/2	20p
BD131	60p
BD132	40p
BD135	40p
BD136	35p
BD139	40p
BD241B	75p
BD242B	75p
BF244B	25p
BF256B	45p
BF257/8	30p
BF259	35p
BF337	30p
BFR80/81	25p
BFY50/51	24p
BFY52	24p
BFY90	75p
MJ2501	225p
MJ2955	90p
MJ3001	225p
MJE2955	130p
MJE3055	70p
MPF102	30p
MPF103/4	30p
MPF105	30p
MPSA12	30p
TIP29C	40p
TIP31B	40p
TIP31C	50p
TIP32A/C	75p
TIP32C	50p
TIP33C	70p
TIP35C	150p
TIP36C	160p
TIP41C	55p
TIP42A	50p
TIP42C	60p
TIP47	90p
TIP54	160p
TIP2955	60p
TIP3055	60p
2N2160	295p
2N2219A	25p
2N2222A	25p
2N2484	25p
2N2646	45p
2N2905A	25p
2N3053	25p
2N3054	55p
2N3055	35p
2N3442	140p
2N3702/3	10p
2N3704/5	10p
2N3773	200p
2N3819	20p
2N3820	40p
2N3866	90p
2N3904/6	15p
2N4871	50p
2N5245	40p
2N5457/8	30p
2N5459	30p
2N6027	30p
3N128	120p
3N140/1	120p
40673	75p
40871/2	100p

DIODES

Type	Price
BY127	12p
OA47	9p
OA90	9p
OA91	9p
OA95	9p
OA200	9p
OA202	10p
IN914	4p
IN4148	4p
IN4001/2	5p
IN4003/4	5p
IN4006/7	7p
IN5401/3	14p
IN5404/7	19p
IS920	9p

BRIDGES

Type	Price
1A50V	19p
1A100V	20p
1A600V	30p
2A50V	30p
2A100V	35p
2A400V	45p
3A200V	60p
4A100V	95p
4A400V	100p
6A50V	80p
6A100V	100p
6A400V	120p
8A100V	150p
10A100V	180p
10A400V	200p

SCRS

Type	Price
1A 50V	70p
5A 400V	50p
8A 600V	140p
16A100V	200p
C106D	45p
MCR101	36p
T1C44	36p
2N3525	130p
2N4444	140p
2N5060/4	40p

ZENERS

Type	Price
2.7V-33V 400MW	9p
1W	15p

TRIACS

Plastic	
3A 400V	60p
6A 400V	70p
6A 500V	90p
8A 400V	75p
8A 500V	95p
12A500V	105p
16A500V	130p
T 2800D	130p
T1206D	50p
T1226D	70p

RAMS

Type	Price
4116L-20	80p

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120v AC £1.60

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270R coil
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12v DC
200R coil
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82S23 Interface	£5	82S23 Freq. Counter (IC 3C4)	ea £5
2716 Housekeeper	£8		

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contents

selektor 12-15

triopede 12-17
An idea from J. Cornelissen
A cybernetic model belonging to the 'Triopodus Electrus Diclopus' family or TED for short. In normal terms it means: a light seeking, three wheeled, electromechanical hybrid. For your domestic pet it will be a close encounter of the third kind.

precision power supply 12-22
A precision power supply capable of providing up to 3 amps at 35 V, incorporating both current limiting and short circuit protection. Meters are included to enable current and voltage output levels to be monitored. Ideal for testing high power equipment!

the XL system 12-29
An introduction to the new Elektor XL audio system. A brief outline of the different parts which will ultimately form a complete high quality audio system.

crescendo 12-30
The start to our XL system. A high quality symmetric/complementary MOSFET stereo power amplifier easily delivering 140 W into 8 Ω. It is short circuit proof, includes speaker protection, power meters, temperature and power-up indication. An amplifier which will leave any serious minded audiophile speechless!

home telephone help 12-40
W. Wijnen
The beginning of our technical answers section. Further modifications to the telephone system published in the September issue which improves the volume level of the speaker in the handset.

soft switching 12-41
An extra refinement to the HighCom sound reduction system published in the March 1981 issue. It provides softswitching by changing the response time of the circuit to increase the decay time, thus eliminating interference.

culmulative index volume 8 1982 12-42

in-car ioniser 12-45
A theory which is rapidly gaining credence relates to the quantity of negative ions in the air. This circuit is one way of increasing the concentration of these ions in the surrounding air, refreshing the environment. In other words fresh air on wheels!

floppy-disk interface for the Junior - part II 12-48
G. de Cuyper
The second and last article describing the modifications that must be made to the hardware and software of the Junior, to be able to run Ohio Scientific software available on diskette. No tracks need to be cut and no mechanical changes need to be made!

a dozen and one sounds 12-59
A single chip containing all the ingredients of a BBC effects laboratory, producing a large number of refreshing sounds.

stop-signal override for model railways 12-62
Model railway enthusiasts know what happens when the stop signal disconnects the supply voltage from a section of track. This little circuit gets over the problem and allows shunting in spite of the stop signal.

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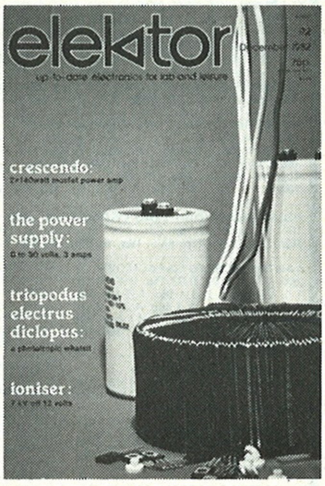
elektor
up-to-date electronics for lab and leisure
crescendo:
the power supply:
triopodus electrus diclopus:
ioniser:

The next issue may be more of a surprise than just being a new issue starting a brand new year. As far as projects are concerned the January issue will continue with the XL system by introducing the accessories for the power amplifier, a video/audio modulator, and . . . it will be a great start to 1983!

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TAG-END CAPACITORS: 64V: 2200 **139p**; 3300 **198p**; 4700 **245p**; **50V**: 2200 **110p**; 3300 **154p**; **40V**: 4700 **160p**; **25V**: 2200 **90p**; 3300 **98p**; 4000, 4700 **98p**; 10,000 **320p**; 15,000 **345p**; **16V**: 22,000 **350p**

POLYESTER CAPACITORS: Axial Lead Type
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 **11p**; 10n, 15n, 18n, 22n **12p**; 33n, 47n, 68n **16p**; 150n **20p**; 220n **30p**; 330n **42p**; 470n **52p**; 680n 1uF **68p**; 2u2 **82p**.
160V: 10nF, 12n, 39n, 100n **11p**; 150n, 220n **17p**; 330n, 470n **30p**; 680n **38p**; 1uF **42p**; 1u5 **45p**; 2u2 **48p**; 4u7 **58p**.
1000V: 1nF **17p**; 10nF **30p**; 15n **40p**; 22n **36p**; 33n **42p**; 47n, 100n **42p**.

POLYESTER RADIAL LEAD CAPACITORS: 250V
10n, 15n, 22n, 27n **6p**; 33n, 47n, 68n, 100n **7p**; 150n, 220n **10p**; 330n, 470n **13p**; 680n **19p**; 1u **23p**; 1u5 **40p**; 2u2 **46p**.

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1000pF/450V **8p**

SIEMENS pcb Type Miniature poly Capacitors
250V

1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 12n, 15n	**7p**
18n, 22n, 27n, 33n, 39n, 47n	**8p**
39n, 56n	**12p**
82n, 100n	**11p**
100V	
100n, 120n	**10p**
150n, 180n	**12p**
220n, 270n	**15p**
330n, 390n	**20p**
470n, 560n	**26p**
680n	**30p**
1uF **34p** 2u2	**50p**

TANTALUM BEAD CAPACITORS
35V: 0.1uF, 0.22, 0.33 **15p**; 0.47, 0.68, 1.0, 1.5 **16p**; 2.2, 3.3 **18p**; 4.7, 6.8 **22p**; 10 **28p**; **16V**: 2.2, 3.3 **16p**; 4.7, 6.8, 10 **18p**; 15, **36p**; 22 **30p**; 33, 47 **40p**; 100 **75p**; **10V**: 15, 22, **26p**; 33, 47 **35p**; 100 **55p**; **6V**: 100 **42p**.

POTENTIOMETERS: Rotary, Carbon, Track 0.25W Log & Lin values.

500Ω, 1KΩ & 2KΩ (Linear only) Single Gang.	**30p**
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Range: 0.5pF to 10nF **4p**. 15nF; 22nF; 33nF; 47nF **5p**. 100nF/30V **7p**. 200nF/6V **8p**.

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0.25W 200Ω 4.7MΩ vert.	**10p**

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200, 220, 250, 270, 300, 330, 360, 390, 470, 800, 800, 820	**21p each**
1000, 1200, 1800, 2200	**30p each**
3300, 4700pF	**60p each**

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2% Metal Film		E24	6p	4p
1% Metal Film		E24	8p	6p

RESISTORS Network S.I.L.
7 Commoned: (8 pins) 100Ω, 680Ω, 1K 2k2, 4K7, 10K, 47K 100K **25p**
8 Commoned: (9 pins) 150Ω, 180Ω, 270Ω, 330Ω, 1K, 2k2, 4K7, 10K, 22K, 47K & 100K **26p**.

DIODES

AA119	15
AA129	20
AAY30	15
BA100	15
BAX13	20
BY100	24
BY126	12
BY127	12
CRO33	250
OA9	40
OA47	12
OA70	12
OA79	15
OA81	20
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	15
1N5404	16
1N5406	17
1N5408	19
1S44	9
1S921	9
6A 100V	40
6A 400V	50
6A [illegible]V	65

NOISE Diode

Z5J 195p

VARICAPS

BA102	50
BB105B	40
BB106	40
BB109B	45
MVAM2	165

BRIDGE RECTIFIERS

1A/50V	18
1A/100V	20
1A/400V	25
1A/600V	34
2A/50V	30
2A/200V	40
2A/400V	46
2A/600V	65
6A/100V	83
6A/400V	95
6A/600V	125
10A/200V	215
10A/600V	298
25A/200V	240
25A/600V	395
BY164	56
VM18 DIL	50

ZENERS

Range: 2V7 to 39V 400mW 8p each
Range: 3V3 to 33V 1.3W 15p each

TRIACS

3A 200V	54
3A 400V	56
8A 100V	60
8A 400V	69
8A 800V	115
12A 100V	78
12A 400V	82
12A 800V	135
16A 100V	103
16A 400V	105
16A 800V	220
25V 500V	220
25A 800V	295
T2800D	120

75 SERIES

75107/8	95
75110	90
75114/5	150
75121/2	130
75150	125
75154	150
75182/3	99
75188/9	55
75322	140
75324	360
75361/3	150
75365	150
75450	86
75451/2	52
75454	85
75491/2	65

SCR THYRISTORS

5A/40V	32
5A 400V	40
5A 600V	48
8A 300V	60
8A 600V	90
12A 100V	78
12A 400V	95
12A 800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5062	32
2N5064	38
2N4444	130

DIAC

ST2 25

TRANSISTORS

AC125	35
AC126/7	35
AC128	30
AC141/2	30
AC176	28
AC187	32
AC188	32
ACY17/18	70
ACY19/20	75
ACY21/22	75
ACY28	75
ACY39/41	85
AD142	120
AD142	120
AD149	79
AD161	42
AD162	42
AF115/6	60
AF117/8	90
AF124/26	70
AF139	40
AF178	75
AF186	70
AF239	55
ASZ21	125
BC107	10
BC107B	12
BC108	10
BC108B	12
BC109	10
BC109B	12
BC109C	12
BC114/5	22
BC117/8	20
BC119	38
BC137/9	40
BC140	30
BC142/3	30
BC147	9
BC147B	10
BC148	9
BC148B	10
BC149	9
BC149C	10
BC153/4	27
BC157/8	10
BC159	11
BC160	45
BC167A	10
BC168C	10
BC169C	10
BC170	15
BC171/2	11
BC173	11
BC177/8	16
BC179	20
BC181	20
BC182/3	10
BC184	10
BC182L	10
BC183L	10
BC184L	10
BC186/7	26
BC212	10
BC212L	10
BC213	10
BC213L	10
BC214	10
BC214L	10
BC237/8	14
BC307B	14
BC308	16
BC327/8	15
BC337/8	15
BC441/61	34
BC477	40
BC516/7	40
BC547/8	12
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BCY39/40	85
BCY41/42	14
BCY45	50
BCY58/59	35
BCY70/71	16
BCY72	20
BCY78	24
BD112	125
BD121	95
BD124	115
BD131/32	48
BD133	70
BD135	45
BD136/37	40
BD138/39	40
BD140	40
BD144/45	198
BD158	55
BD205/6	110
BD222	85
BD245	45
BD378	70
BD434	55
BD517	75
BD695A	125
BD696A	125
BDY56	180
BDY60	160
BF115	35
BF154/8	25
BF167	29
BF173	27
BF177	25
BF178	30
BF179	35
BF180/2	38
BF184/5	38
BF194/5	12
BF196/7	12
BF198/9	18
BF200	300
BF224A	25
BF224B	29
BF245	30
BF256A	35
BF256B	45
BF257/8	32
BF259	35
BF274	42
BF336/7	40
BF451	35
BF594/5	30
BFR39/40	23
BFR41/79	23
BFR80/81	25
BFR98	105
BFX29	28
BFX81	45
BFX84	28
BFX85/6	28
BFY18	50
BFY50/51	23
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BFY53	32
BFY55/6	32
BFY64	35
BFY81	120
BFY90	80
BRY39	40
BSX20	20
BSX26/29	34
BSX78	45
BSY26	30
BSY95A	25
BU105	170
BU205	190
BU206	200
BU208	200
BUY69C	225
E421	250
MD8001	250
MJ490	90
MJ491	175
MJ2955	70
MJE170	150
MJE180	150
MJE340	54
MJE370	100
MJE371	100
MJE520	95
MJE521	95
MJE2955	99
MJE3055	70
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OC42/44	75
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OC76/77	50
OC81/82	50
OC83/84	40
OC170/71	50
OC200	50
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TIP3055	60
TIS43	32
TIS44/5	45
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TIS59/74	50
TIS88A	50
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UC734	65
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VN10KM	55
VN46AF	78
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VN89AF	96
ZTX107/8	11
ZTX109	12
ZTX212	28
ZTX300	13
ZTX301	16
ZTX302	16
ZTX303	25
ZTX304	17
ZTX314	25
ZTX326	30
ZTX341	30
ZTX451	23
ZTX500	14
ZTX501/2	15
ZTX503	18
ZTX504	25
ZTX531	25
ZTX550	25
2N697	23
2N698	40
2N699	48
2N706A	19
2N708	19
2N918	35
2N1131/2	24
2N1302	45
2N1303	65
2N1304/5	60
2N1306/7	65
2N1308	68
2N1613	30
2N1670	150
2N1671B	160
2N2160	295
2N2217	45
2N2218A	25
2N2219A	28
2N2220A	26
2N2221A	26
2N2222A	25
2N2297	25
2N2303	45
2N2368	25
2N2369A	18
2N2476	50
2N2483/4	27
2N2646	45
2N846	80
2N2904/5	26
2N2906/7	26
2N2907A	26
2N2926G	10
2N3011	28
2N3053	26
2N3054	58
2N3055	48
2N3108	45
2N3252	46
2N3302	30
2N3441/2	140
2N3614/5	199
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2N3702/3	10
2N3704/5	10
2N3706/7	10
2N3708/9	10
2N3710/11	10
2N3713	140
2N3771	179
2N3772	195
2N3773	210
2N3819	22
2N3820	38
2N3822/3	45
2N3824	65
2N3866	90
2N3870	150
2N3903/4	15
2N3905/6	15
2N3906	17
2N4037	46
2N4041	40
2N4058	10
2N4061(2	10
2N4064	115
2N4069	45
2N4220	78
2N4234/6	48
2N4264	24
2N4286	15
2N4289	18
2N4314	78
2N4400	18
2N4427	80
2N4859	78
2N4871	55
2N4898	135
2N4901	175
2N4921	55
2N4922	70
2N5135/6	20
2N5138	18
2N5172	18
2N5179	45
2N5180	45
2N5190/1	75
2N5194	80
2N5305/8	30
2N5457/8	30
2N5459	30
2N5485	36
2N5777	45
2N5879	190
2N6027	32
2SA671	250
2SA715	60
2SC495	70
2SC496	70
2SC1061	250
2SC1096	85
2SC1162	30
2SC1173	125
2SC1306	100
2SC1307	150
2SC1449	85
2SC1678	140
2SC1679	190
2SC1923	50
2SC1945	225
2SC1963	90
2SC1957	90
2SC1969	140
2SC2028	85
2SC2029	210
2SC2078	170
2SC2091	85
2SC2314	85
2SC2166	165
2SC2335	225
2SC2547	30
2SC2612	225
2SD234	74
2SK45	90
2SK288	225
2SJ83	225
2SJ85	225
3N128	112
3N140	112
40097	120
40250	95
40311	60
40313	130
40315	90
40316	95
40317/20	80
40323	60
40324	100
40326/7	70
40347	90
40348	120
40360	60
40361/2	70
40407/8	75
40411	285
40412	90
40467A	130
40468	85
40594	105
40603	110
40636	175
40673	75
40871/2	90

RF CHOKES Miniature PCB type

1uH, 2u2, 4u7, 10u, 22u, 33u, 47u, 100u, 220u, 330u, 470u	30p
1mH, 1m5, 2m2, 4m7, 10mH	35p
22m, 33m, 43m	60p
100m	75p

COMPUTER ICs

1702	350
1802CP	650
2102-2	100
2114-450n	85
2114L-300n	90
2114L-200n	95
2147	425
2532-450n	350
2564	£12
2708	225
2716-5V	215
2732-450n	350
2764	999
3242	590
4816-100nS	225
4027	190
4116-150n	85
4116-200n	80
4118-250	325
4164-200n	500
4334-3 CMOS	
2114-3	325
4816-100nS	225
4864-364K	500
5101-450	220
6116-150nS	390
6116L 120nS	550
6117-100n	490
6502CPU	325
6503	600
6504-250	550
6505	600
6520PIA	100
6521	100
6522VIA	300
6530	£11
6352RRIOT	570
6545RTC	899
6551ACIA	650
6592PC	£20
6800	225
6802	250
6803	850
6804	160
6805	670
6808	520
6809	630
6810	115
6820	100
6821	100
68B21	220
6840	375
6843	£12
6845	685
6847	650
6850	110
6852	250
6854	599
6875	500
68000	£70
74C922	420
8080A	250
8085A	350
8118-10	250
8123	125
8155	350
8156	350
81LS95	80
81LS96	80
81LS97	80
81[illegible]	85
8202	£25
8212	110
8214	425
8215	300
8216	100
8224	110
8225	£11
8226	250
8228	220
8243	270
8250	850
8251A	250
8253	400
8255	225
8256AC	£35
8257-5	400
8259	395
8271	£36
8279	385
8284	350
8288	£10
8P8304BN	250
8T26A	99
8T27	150
8T28A	120
8T31	350
8T95	90
8T97N	90
9364AP	550
9602	220
AM26L531C	125
AM26L532A	125
AY-3-1015	300
AY-5-1350	388
AY-5-2376	600
AY-5-2376	600
COM8017	275
COM8116	700
DM8131	275
DS3691N	320
DS88LS120N	275
FD1771	£15
FD1791	£22
FD1793	£23
FD1795	£28
FD1799	£28
FD1797	£28
1HD26501	75
IM6402	380
INS8060N	1050
INS8154N	£9
MC1488	55
MC1489	55
MC14411	690
MC14412	790
MC3446	250
MC3447P	315
MK3886-2M	£7
MM1702A	300
MM5280D	695
MM5303	635
MM5307	1275
MM5387A	475
MM58174	770
MM74C922	420
RO-3-2513L	650
RO-3-2513U	650
SFF9634E	800
TMS2716-3V	725
TMS6011	365
TMS9928	£30
ULN2003	90
UPD7002	440
Z80CPU 2.5	299
Z80ACPU 4M	300
Z80 CTC	250
Z80A CTC	260
Z80B	£11
Z80 DART	495
Z80A DART	550
Z80 DMA	675
Z80 DART	698
Z80 PIO	260
Z80A PIO	275
Z80 SIO-1	850
Z80A DIO	980

LINEAR ICs

555CMOS	80
702	75
709 14 pin	40
709C 8 pin	35
710	48
741 8 pin	14
747C 14 pin	65
748C 8 pin	36
753 8 pin	185
810	159
9400CJ	350
AY-1-1320	225
AY-1-5050	99
AY-1-5051	160
AY-1-6720	210
AY-3-1270	730
AY-3-1350	350
AY-3-8910	438
Booklet for AY-3-8910	150
AY-3-8912	625
AY-5-1230	450
AY-5-1317A	630
AY-5-1350	388
AY-5-3500	350
AY-5-4007D	520
AY-5-8100	775
CA3011	130
CA3012	175
CA3014	275
CA3018	86
CA3019	80
CA3020	210
CA3023	210
CA3028A	95
CA3035	255
CA3036	270
CA3043	275
CA3045	365
CA3046	70
CA3048	220
CA3059	285
CA3075	213
CA3080E	70
CA3081	190
CA3086	48
CA3089E	215
CA3090AQ	375
CA3123E	165
CA3130	90
CA3140	40
CA3160	95
CA3161	160
CA3162E	450
CA3189	200
HA1336W	240
HA1388	255
ICL7106	750
ICL7107	975
ICL7611	99
ICL7660	190
ICL8038CC	300
ICL8211A	150
ICM7205A	1150
ICM7207	475
ICM7215	1050
ICM7216AJ	1950
ICM7216B	1950
ICM7216C	1950
ICM7217A	790
ICM7224	785
ICM7240	300
ICM7555	80
ICM7556	150
LA3350	250
LA4031P	340
LA4032	295
LA4400	440
LC7130	340
LC7120	300
LC7137	395
LF347	150
LF351	48
LF353	95
LF355	85
LF356	95
LF357	110
LF398	475
LM10	325
LM301AO	24
LM307	45
LM308T	95
LM311	70
LM318N	150
LM319	215
LM324A	30
LM334Z	90
LM335Z	128
LM339	47
LM348	64
LM349	115
LM358	60
LM377	175
LM379	480
LM380	75
LM381N	145
LM382	115
LM384	140
LM386	90
LM387	120
LM389	95
LM393	100
LM725CN	325
LM733	70
LM1458	45
LM1871	325
LM2917	195
LM301	24
LM307	45
LM3302	75
LM3900	50
LM3909N	85
LM3911	125
LM3914	250
LM3915	250
LM3916	250
LM13600	110
LS7220	280
M252AA	625
M253AA	1150
M51513L	230
M51515L	320
M51516L	475
MB3712	220
MB3756	440
MC1204	250
MC1301	79
MC1303	88
MC1304P	260
MC1310P	150
MC1445	250
MC145106	695
MC1458	35
MC1469	300
MC1494	694
MC1495	350
MC1496L	70
MC1596	225
MC1648	290
MC1709G	90
MC3302	90
MC3340P	120
MC3360P	120
MC3401	65
MC3403	75
MC3405	150
MC3423	180
MC4016	80
MFC6040	75
MK50398	635
ML924	275
MSM5526	820
NE515	275
NE529	225
NE531	140
NE534	150
NE543K	225
NE544	210
NE555	16
NE556	45
NE560	325
NE561	398
NE562B	410
NE564	420
NE565A	120
NE566	155
NE567V	140
NE570	410
NE571	400
NE5534A	150
OM335	750
RC4136D	69
S566B	225
SAB3209	425
SAB3210	325
SAB3271	485
SAB4209	595
SG3402	295
SL490	350
SN76003N	350
SN76013	350
SN76018	148
SN76023N	350
SN76023ND	240
SN76033N	350
SN76115N	215
SN76131	125
SN76227N	95
SN76477	420
SN76488	480
SN76660	120
SP8629	299
TA7210	150
TA7204	200
TA7205	90
TA7205A	225
TA7222	150
TA7310	160
TAA621AX1	295
TAA661A	190
TAA700	275
TAA900	395
TAD100	159
TBA120S	70
TBA540Q	275
TBA550Q	330
TBA641BX or BX11	290
TBA651	190
TBA800	80
TBA810	95
TBA820	80
TBA920Q	200
TBA950	300
TBA990Q	350
TBA540	275
TCA220	350
TCA270Q	350
TCA280A	220
TCA940	175
TCA965	120
TDA1004	290
TDA1008	310
TDA1010	198
TDA1022	499
TDA1024	115
TDA1034	350
TDA1490	325
TDA2002	325
TDA2004	495
TDA2020	320
TDA2030	295
TDB0701	420
TL170	50
TL061CP	40
TL062CP	60
TLO64CN	98
TLO71CP	24
TLO72CP	45
TLO74CN	100
TLO81CP	24
TLO82CP	45
TLO83CP	75
TLO84CN	90
TLO91CP	55
UA2240	120
UA78540	230
UAA170	170
UAA180	170
UAA1003-3	935
ULN2003	85
ULN2004	90
ULN2283	100
UPC575	350
UPC1025H	375
UPC1182	330
UPC1156H	290
UPC1366	195
XR2206	300
XR2207	375
XR2211	575
XR2216	675
XR2266	360
ZN414	80
ZN419E	190
ZN423E	135
ZN424E	130
ZN425E	345
ZN426E	300
ZN427E	600
ZN428E	410
ZN429E	210
ZN459	570
ZN1034E	200
ZN1040E	675
ZNA234E	850

TTL74

7400	11
7401	11
7402	11
7403	12
7404	13
7405	15
7406	20
7407	20
7408	14
7409	14
7410	14
7411	16
7412	18
7413	18
7414	24
7416	20
7417	20
7420	15
7421	20
7422	20
7423	20
7425	18
7426	18
7427	15
7428	26
7430	14
7432	22
7433	22
7437	25
7438	22
7440	15
7441	55
7442	32
7443	90
7444	90
7445	55
7446	60
7447	40
7448	45
7450	16
7451	16
7453	16
7454	16
7460	16
7470	35
7472	24
7473	26
7474	20
7475	25
7476	25
7480	48
7481	120
7482	65
7483	38
7484	70
7485	60
7486	20
7489	170
7490	20
7491	35
7492	25
7493	25
7494	35
7495	35
7496	35
7497	90
74100	80
74104	50
74105	55
74107	20
74109	25
74110	35
74111	55
74112	170
74116	50
74118	55
74119	60
74120	60
74121	25
74122	35
74123	35
74125	35
74126	35
74128	35
74132	30
74136	28
74141	55
74142	175
74143	210
74144	210
74145	50
74147	75
74148	60
74150	50
74151	40
74153	40
74154	55
74155	40
74156	40
74157	30
74159	80
74160	60
74161	48
74162	40
74163	40
74164	40
74165	48
74166	48
74167	150
74170	125
74172	250
74173	60
74174	54
74175	55
74176	40
74177	45
74178	80
74179	80
74180	40
74181	115
74182	60
74184	90
74185	95
74186	470
74188	250
74190	48
74191	46
74192	46
74193	45
74194	40
74195	40
74196	46
74197	40
74198	80
74199	84
74221	54
74246	120
74247	120
74248	120
74249	120
74251	65
74259	150
74265	55
74273	150
74276	120
74278	100
74279	50
74283	50
74284	155
74285	155
74290	105
74293	80
74297	236
74298	100
74351	195
74365	30
74366	30
74367	30
74368	30
74390	75
74393	90
74490	95

74C

74C244	195
74C245	195
74C373	240
74C374	245
74C922	420

74L

74L00	68
74L04	85
74L30	50
74L47	380
74L75	145
74L85	349
74L121	165
74L123	325

74S

74S00	38
S02	30
S03	30
S04	40
S05	60
S08	60
S20	40
S32	70
S74	75
S86	85
S112	85
S114	85
S132	110
S133	60
S138	180
S157	250
S158	210
S188	210
S189	158
S194	320
S195	795
S201	320
S225	510
S241	390
S251	70
S257	250
S262	850
S287	300
S288	210
S289	195
S301	350
S412	380
S470	325
S471	620
S472	1150
S475	825
S571	620

74LS

LS00	11
LS01	11
LS02	11
LS03	12
LS04	12
LS05	13
LS08	12
LS09	12
LS10	13
LS11	13
LS12	13
LS13	20
LS14	26
LS15	13
LS20	13
LS21	13
LS22	13
LS26	14
LS27	13
LS28	14
LS30	13
LS32	13
LS33	15
LS37	15
LS38	15
LS40	13
LS42	28
LS47	35
LS48	45
LS49	50
LS51	14
LS54	14
LS55	14
LS63	120
LS73	18
LS74	18
LS75	20
LS76	18
LS78	18
LS83	36
LS85	42
LS86	16
LS90	28
LS91	60
LS92	32
LS93	26
LS95	40
LS96	95
LS107	40
LS109	28
LS112	26
LS113	22
LS114	22
LS122	36
LS123	36
LS124	90
LS125	24
LS126	25
LS132	35
LS133	30
LS136	24
LS138	25
LS139	32
LS145	70
LS147	100
LS148	70
LS151	40
LS153	40
LS155	35
LS156	36
LS157	27
LS158	30
LS160	32
LS161	35
LS162	35
LS163	35
LS164	40
LS165	50
LS166	65
LS168	84
LS170	75
LS173	65
LS174	50
LS175	45
LS181	90
LS183	180
LS190	45
LS191	45
LS192	45
LS193	45
LS194	35
LS195	35
LS196	45
LS197	45
LS200	275
LS202	275
LS221	55
LS240	65
LS241	65
LS242	65
LS243	65
LS244	55
LS245	70
LS247	50
LS248	55
LS249	55
LS251	30
LS253	35
LS257	30
LS258	35
LS259	58
LS260	22
LS261	100
LS266	20
LS273	54
LS275	125
LS279	30
LS280	90
LS283	40
LS290	50
LS293	40
LS295	75
LS298	80
LS299	150
LS300	175
LS302	175
LS320	200
LS323	195
LS324	168
LS325	295
LS326	240
LS327	240
LS347	95
LS348	90
LS352	62
LS353	62
LS362	750
LS363	150
LS364	150
LS365	30
LS366	32
LS367	30
LS368	35
LS373	65
LS374	65
LS375	50
LS377	85
LS378	80
LS379	110
LS384	395
LS385	250
LS390	50
LS393	45
LS395	125
LS399	150
LS445	100
LS471	620
LS490	200
LS541	120
LS640	180
LS641	180
LS645	180
LS668	125
LS669	120
LS670	100
LS673	550

SWITCHES

TOGGLE 2A, 250V

SPST	33p
DPDT	44p

SUB-MIN TOGGLE

SPST on/off	54p
SPDT c/over	60p
SPDT centre off	85p
SPDT biased both ways	105p
DPDT 6 tags	75p
DPDT centre off	88p
DPDT biased both ways	145p
DPDT 3 positions on/on/on	185p
3-pole 2 way	205p

SLIDE 250V:

DPDT 1A	14p
DPDT 1A c/off	15p
DPDT ½A	13p

PUSHBUTTON 6A
with 10mm Button

SPDT latching	99p
DPDT latching	145p
SPDT moment	99p
DPDT moment	145p

Mini Non Locking

Push to Make	15p
Push to Break	25p

DIL SWITCHES
(SPST) 4 way **70p**; 6 way **85p**; 8 way **90p**; 10 way **145p**.
(SPDT) 4 way **190p**.

ROTARY SWITCHES:
(Adjustable Stop type)
1 pole/2 to 12 way; 2p/2 to 6 way; 3 pole/2 to 4 way; 4p/2 to 3 way **45p**

ROTARY: Mains DP 250V 4 Amp on/off **56p**

ROTARY: (Mak-a-switch)
Make a multiway switch. Shafting assembly has adjustable stop. Accommodates up to 6 wafers (max. 6 pole/12 way - DP switch)
Mechanism only **90p**

WAFERS: (make before break) to fit the above switch mechanism.
1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6-/2 way **65p**
Mains DP 4A Switch to fit **45p**
Spacers **4p**. Screen **6p**

ROCKER: 5A/250V SPST	28p
ROCKER: 10A/250V SPDT	38p
ROCKER: 10A/250V DPDT c/off	95p
ROCKER: 10A/250V DPST with neon	85p

THUMBWHEEL Mini front mounting

Decade Switch Module	220p
B.C.D. Switch Module	275p
Mounting Cheeks (per pair)	75p

ETI PROJECTS
We stock most of the parts

JUMPER LEADS (Ribbon Cable Assembly)

Length	14 pin	16 pin	24 pin	40 pin
Single ended DIP (Header Plug) Jumper				
24 inches	145p	165p	240p	380p
Double ended DIP (Header Plug) Jumper				
6 inches	185p	205p	300p	465p
12 inches	198p	215p	315p	490p
24 inches	210p	235p	345p	540p
36 inches	230p	250p	375p	595p

IDC Header Socket Jumper Leads 24"

	20 pin	26 pin	34 pin	40 pin
Single ended	160p	200p	260p	300p
Double ended	290p	370p	480p	525p

PIEZOI TRANSDUCERS
PB2720 **55p**

TRANSFORMERS: Prim. 240V

6-0-6V; 9-0-9V; 12-0-12V 100mA **98p**

pcb mounting. Miniature, Split Bobbin
3VA: 2x6V-0.25A; 2x9V-0.15A; 2x12V-0.12A; 2x15V-0.1A **200p**
6VA: 2x6V-0.5A; 2x9V-0.3A; 2x12V-0.25A; 2x15V-0.2A **270p**

Standard Split Bobbin type:
6VA: 2x6V-0.5A; 2x9V-0.4A; 2x12V-0.3A; 2x15V-0.25A **220p**
12VA: 2x4.5V-1.3A; 2x6V-1A; 2x9V-0.6A; 2x12V-0.5A; 2x15V-0.4A; 2x20V-0.3A **295p** (35p p&p)
24VA: 2x6V-1.5A; 2x9V-1.2A; 2x12V-1A; 2x15V-0.8A; 2x20V-0.6A **330p** (60p p&p)
50VA: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x15V-1.5A; 2x20V-1.2A; 2x25V-1A; 2x30V-0.8A **465p** (60p p&p)
100VA: 2x12V-4A; 2x15V-3A; 2x20V-2.5A; 2x25V-2A; 2x30V-1.5A; 2x50V-1A **920p** (75p p&p charge to be added over and above our normal postal charge).

VEROBOARD 0.1in

	clad	plain
2½ × 3¾	80p	
2½ × 5	91p	—
3¾ × 3¾	91p	—
3¾ × 5	105p	87p
3¾ × 17	360p	232p
4¾ × 17	470p	—
Pkt of 100 pins		50p
Spot face cutter		135p
Pin insertion tool		178p

VQ Board	180
DIP Board	350
Vero Strip	374

PROTO DECs

Veroblock	405p
S-Dec	350p
Eurobreadboard	520p
Bimboard 1	575p
Superstrip SS2	1350p

VERO WIRING PEN + spoool **340p**
Spare spool **75p**
Combs **6p**

DALO ETCH RESIST PEN
Plus spare tip **90p**

FERRIC CHLORIDE
1 lb bag Anhydrous
195p + 50p P&P

ULTRASONIC TRANSDUCER
40KHz **325 pr**

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Fibre glass	Single sided	Double sided	S R B P 95 × 85
6 × 6	90p	110p	95p
6 × 12	150p	195p	

DIL SOCKETS

	Low Prof	Wire Wrap
8pin	8p	25p
14pin	10p	35p
16pin	10p	42p
18pin	16p	52p
20pin	20p	60p
22pin	22p	65p
24pin	25p	70p
28pin	28p	80p
40pin	30p	99p

EDGE CONNECTORS

	.1	.156
2 × 15 way	—	140p
2 × 18 way	180p	145p
2 × 22 way	199p	200p
2 × 23 way	190p	—
2 × 25 way	225p	220p
2 × 28 way	210p	—
2 × 30 way	245p	—
2 × 36 way	295p	—
2 × 40 way	315p	—
2 × 43 way	395p	—
2 × 75 way	550p	—

ANTEX SOLDERING IRON

C-15W	450p	CX17W	475p
CCN-15W	495p	CX25W	500p
Spare tips, assorted sizes			65p
Spare Elements			210p
Iron stand with sponge			165p

Soldercon Pins
100 pins **70p**
500 pins **325p**

VOLTAGE REGULATORS

	+ ve		− ve	
1A	T03	Metal case		
5V	7805	145p	7905	220p
12V	7812	145p	7912	220p
15V	7815	145p	7915	220p
18V	7818	145p		
1A	TO220	Plastic casing		
5V	7805	40p	7905	45p
12V	7812	40p	7908	60p
15V	7815	40p	7912	45p
18V	7818	40p	7915	45p
24V	7824	40p	7918	45p
			7924	45p
100mA	TO92	Plastic casing		
5V	78L05	30p	79L05	60p
6V	78L62	30p		—
8V	78L82	30p		—
12V	78L12	30p	79L12	60p
15V	78L15	30p	79L15	60p

CA3085	95p
LM300H	170p
LM304H	170p
LM305H	140p
LM309K	135p
LM317K	320p
LM317KP	99p
LM317H	280p
LM323K	500p
LM325N	240p
LM326N	240p
LM337	175p
LM723	35p
TAA550	50p
TBA625B	75p
TDA1412	150p
78HO5 + 5V/5A	550p
78H12 + 12V/5A	580p
78HG + 5V to + 25V 5A	599p
79HG-2.25V to 24V 5A	685p

IDC CONNECTORS

	Female Header Socket	PCB Plugs with latch Pins Strt	pins Angle	Female Header Plug	PCB Pins Angled
10 way	90p	99p	85p	65p	
16 way	130p	150p	110p	78p	
20 way	145p	166p	125p	90p	
26 way	175p	200p	150p	110p	
34 way	205p	236p	169p	135p	
40 way	220p	250p	190p	150p	
50 way	235p	270p	200p	175p	
60 way	—	—	230p	220p	

EURO CONNECTORS

	Female Socket Strt Pins	Female Socket Angle Pins	Male Plug Strt Pins	Male Plug Angle Pins
DIN41617 31way	170p	—	—	175p
DIN41612 2 × 32 A + B	285p	325p	220p	295p
DIN41612 2 × 32 A + C	300p	340p	240p	300p
DIN41612 3 × 32 A + B + C	360p	385p	260p	400p

DIL PLUG (Headers)

	Solder	IDL
14pin	40p	99p
16pin	49p	105p
24pin	88p	178p
40pin	250p	255p

RIBBON CABLE
price per foot

	Grey	Color
10 way	12p	22p
16 way	18p	32p
20 way	25p	40p
24 way	35p	50p
34 way	48p	60p
40 way	55p	75p
50 way	65p	90p
64 way	85p	110p

ZIF DIL SOCKETS

24 pin	575p
28 pin	820
40 pin	975p

D CONNECTORS: Miniature

	9 way	15way	25way	37way
Plugs				
Solder lugs	80p	110p	160p	250p
Angle Pins	160p	210p	250p	355p
W/Wrap Pins	120p	130p	195p	295p
Sockets				
Solder lugs	110p	160p	210p	350p
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Covers	95p	95p	95p	110p

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36" long, Double Ended, F/F	1050p
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0-1mA
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0-10mA
0-50mA
0-100mA
0-500mA
0-1A
0-2A
0-25V
0-50V AC
0-300V AC
"S"
"VU"
495p each

CRYSTALS

32.768KHz	100
100KHz	235
200KHz	268
455KH	370
1MHz	275
1.008M	275
1.28MHz	392
1.6MHz	395
1.8NHz	395
1.8432M	200
2.0MHz	225
2.4576M	200
3.278M	150
3.5794M	98
3.6864M	300
4.0MHz	150
4.032MHz	290
4.80MHz	200
4.194304M	200
4.433619M	100
5.0MHz	160
5.185MHz	300
5.24288M	390
6.0MHz	140
6.144MHz	150
6.5536MHz	225
7.0MHz	150
7.168MHz	250
7.68MHz	200
8.0MHz	150
8.08333M	395
8.86723M	175
9.00MHz	150
10.0MHz	175
10.24MHz	200
10.7	150
12.0NHz	175
12.528M	300
14.31814M	170
16.0MHz	200
18.0MHz	180
18.432M	150
20.0MHz	200
19.968MHz	150
24.0MHz	170
24.930MHz	325
26.69M	150
27.648M	170
27.145M	190
38.66667M	175
48.0MHz	170
100.0MHz	295
116.0MHz	250

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D P C O
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4001	10
4002	12
4006	50
4007	14
4008	32
4009	24
4010	24
4011	10
4012	16
4013	20
4014	46
4015	40
4016	20
4017	32
4018	45
4019	25
4020	42
4021	40
4022	40
4023	13
4024	32
4025	13
4026	80
4027	20
4028	39
4029	45
4030	15
4031	125
4032	80
4033	125
4034	140
4035	45
4036	275
4037	115
4038	110
4039	250
4040	40
4041	40
4042	40
4043	40
4044	40
4045	105
4046	46
4047	40
4048	40
4049	25
4050	25
4051	45
4052	60
4053	50
4054	85
4055	85
4056	85
4057	1915
4059	435
4060	45
4061	1195
4062	995
4063	85
4066	24
4067	245
4068	14
4069	16
4070	13
4071	13
4072	13
4073	15
4075	13
4076	50
4077	13
4078	15
4081	13
4082	13
4085	50
4086	60
4089	125
4093	20
4094	70
4095	95
4096	70
4097	290
4098	75
4099	110
4160	95
4161	99
4162	99
4163	99
4174	99
4175	105
4194	105
4408	790
4409	790
4410	725
4411	675
4412	775
4415	480
4419	280
4422	770
4435	850
4440	999
4450	350
4451	350
4490	350
4500	675
4501	28
4502	60
4503	40
4504	75
4505	185
4506	35
4507	35
4508	130
4510	46
4511	45
4512	50
4513	199
4514	115
4515	115
4516	55
4517	275
4518	40
4519	30
4520	50
4521	110
4522	125
4526	70
4527	65
4528	70
4529	150
4530	90
4531	130
4532	70
4534	455
4536	275
4538	90
4539	110
4541	140
4543	80
4544	150
4548	40
4549	375
4553	245
4554	190
4555	35
4556	35
4557	320
4558	120
4559	395
4560	160
4561	104
4562	495
4566	165
4568	250
4569	175
4572	30
4580	460
4581	250
4582	99
4583	99
4584	48
4585	99
4597	330
4598	290
4599	290
40085	90
40097	45
40098	193
40100	215
40101	130
40102	140
40103	175
40104	95
40105	110
40106	46
40107	60
40108	450
40109	100
40110	300
40114	240
40161	194
40163	65
40174	65
40175	75
40181	220
40182	90
40192	90
40193	68
40194	90
40195	72
40244	195
40245	195
40257	195
40373	240
40374	245
45106	595

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Rectangle Stackable LEDs Red, Green or Yell	18
Triangular LEDs Red	18
Green or yellow	22
LD271 Infra Red	46
SFH205 Detector	118
TIL32 Infra Red	58
TIL78 Detector	60
TIL38	45
TIL100	80
BARGRAPH. Red 10 segments	225

ISOLATORS

IL74	55
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4N33 Photo Darlington	135

7 Segment Displays

TIL307	675
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TIL313 .3" CC	105
TIL321 .5" CA	115
TIL322 .5" CC	115
DL704 .3" CC	99
DL707 .3" CA	99
FND357 Red	120
FND500	115
.3" Green CA	150
.6" Green CA	215
.3" ± 1 Red CA	150
.3" ± 1 Green CA	150
DVM176	1885
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ABC

decoder

What is a TUN?
What is 10 n?
What is the EPS service?
What is the TQ service?
What is a missing link?

Semiconductor types
Very often, a large number of equivalent semiconductors exist with different type numbers. For this reason, 'abbreviated' type numbers are used in Elektor wherever possible:

- '741' stand for μA741, LM741, MC1741, MIC741, RM741, SN72741, etc.
- 'TUP' or 'TUN' (Transistor, Universal, PNP or NPN respectively) stand for any low frequency silicon transistor that meets the following specifications:

$U_{CEO, max}$	20 V
$I_{C, max}$	100 mA
$h_{fe, min}$	100
$P_{tot, max}$	100 mW
$f_{T, min}$	100 MHz

Some **'TUN's** are: BC107, BC108 and BC109 families; 2N3856A, 2N3859, 2N3860, 2N3904, 2N3947, 2N4124. Some **'TUP's** are: BC177 and BC178 families; BC179 family with the possible exeption of BC159 and BC179; 2N2412, 2N3251, 2N3906, 2N4126, 2N4291.

- 'DUS' or 'DUG' (Diode Universal, Silicon or Germanium respectively) stands for any diode that meets the following specifications:

	DUS	DUG
$U_{R, max}$	25 V	20 V
$I_{F, max}$	100 mA	35 mA
$I_{R, max}$	1 μA	100 μA
$P_{tot, max}$	250 mW	250 mW
$C_{D, max}$	5 pF	10 pF

Some **'DUS'** are: BA127, BA217, BA218, BA221, BA222, BA317, BA318, BAX13, BAY61, 1N914, 1N4148.
Some **'DUG's** are: OA85, OA91, OA95, AA116.

- 'BC107B', 'BC237B', 'BC547B' all refer to the same 'family' of almost identical better-quality silicon transistors. In general, any other member of the same family can be used instead.

BC107 (-8, -9) families:
BC107 (-8, -9), BC147 (-8, -9), BC207 (-8, -9), BC237 (-8, -9), BC317 (-8, -9), BC347 (-8, -9), BC547 (-8, -9), BC171 (-2, -3), BC182 (-3, -4), BC382 (-3, -4), BC437 (-8, -9), BC414

BC177 (-8, -9) families:
BC177 (-8, -9), BC157 (-8, -9), BC204 (-5, -6), BC307 (-8, -9), BC320 (-1, -2), BC350 (-1, -2), BC557 (-8, -9), BC251 (-2, -3), BC212 (-3, -4), BC512 (-3, -4), BC261 (-2, -3), BC416.

Resistors and capacitor values
When giving component values, decimal points and large numbers of zeros are avoided wherever possible. The decimal point is usually replaced by one of the following abbreviations:
p (pico-) = 10^{-12}
n (nano-) = 10^{-9}
μ (micro-) = 10^{-6}
m (milli-) = 10^{-3}
k (kilo-) = 10^{3}
M (mega-) = 10^{6}
G (giga-) = 10^{9}

A few examples:
Resistance value 2k7: 2700 Ω.
Resistance value 470: 470 Ω.
Capacitance value 4p7: 4,7 pF, or 0.000 000 000 004 7 F . . .
Capacitance value 10n: this is the international way of writing 10,000 pF or .01 μF, since 1 n is 10^{-9} farads or 1000 pF.
Resistors are ¼ Watt 5% carbon types, unless otherwise specified.
The DC working voltage of capacitors (other than electrolytics) is normally assumed to be at least 60 V. As a rule of thumb, a safe value is usually approximately twice the DC-supply voltage.

Test voltages
The DC test voltages shown are measured with a 20 kΩ/V instrument, unless otherwise specified.

U, not V
The international letter symbol 'U' for voltage is often used instead of the ambiguous 'V'. 'V' is normally reserved for 'volts'. For instance: $U_b = 10$ V, not $V_b = 10$ V.

Mains voltages
No mains (power line) voltages are listed in Elektor circuits. It is assumed that our readers know what voltage is standard in their part of the world!
Readers in countries that use 60 Hz should note that Elektor circuits are designed for 50 Hz operation. This will not normally be a problem; however, in cases where the mains frequency is used for synchronisation some modification may be required.

Technical services to readers
- **EPS service.** Many Elektor articles include a lay-out for a printed circuit board. Some — but not all — of these boards are available ready-etched and predrilled. The 'EPS print service list' in the current issue always gives a complete list of available boards.
- **Technical queries.** Members of the technical staff are available to answer technical queries (relating to articles published in Elektor) by telephone on Mondays from 13.30 to 16.15. Letters with technical queries should be addressed to: Dept. TQ. Please enclose a stamped, self addressed envelope; readers outside U.K. please enclose an IRC instead of stamps.
- **Missing link.** Any important modifications to, additions to, improvements on or corrections in Elektor circuits are generally listed under the heading 'Missing Link' at the earliest opportunity.

BBC Micro Computer

Please phone for availability

BBC Model B **£399** (incl. VAT)
(Carr £8/unit)

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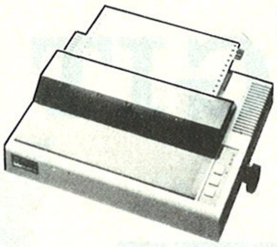
EPSON MX 80 and 100F/T3



MX 80	80CPS	80 cols
MX 100	100CPS	136 cols

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Bi-directional, Bit Image
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MX 80 F/T3	**£ 325**
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(£ 8 Carr/Printer)

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2,000 fanfold papers with perforated margin ... **£ 15.00** + £ 3.50 carriage
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VARIETY OF PRINTER INTERFACES IN STOCK

RIBBONS FOR PRINTERS

GP100A	**£ 6.50**	EPSON MX80	**£ 7,50**
		NEC PC8035	**£ 7.50**

AMPHENOL CONNECTORS

37 way Centronix Type **£5.50**
(1 DC or Solder Type)
25 way IEEE Type **£5.50**

MICRODOCTOR

This is not a logic analyser or an oscilloscope. It tests a microsystem and gives a printed reprint on RAM, ROM and I/O — it will print memory map, search for code, check dataline shorts and operates peripherals and even disassembles the ROM.
Microdoctor complete with PSU, printer, proble cable and two configuration board .... **£ 295**

UV ERASERS

UV1B up to 6 Eproms	£ 47.50
UV140 up to 14 Eproms	£ 61.50
UV1T with Timer	£ 60.00
UV141 with Timer	£ 78.00

(Carr £ 2/eraser)

All erasers are fitted with mains switches and safety interlocks.

MICROTIMER

6502 Based Programmable clock timer with
- 224 switching times/week cycle
- 24 hour 7 day timer
- 4 independent switch outputs directly interfacing to thyristor/triacs
- 6 digit 7 seg. display to indicate real time, ON/OFF and Reset times
- Output to drive day of week switch and status LEDs.

Full details on request. Price for kit **£57.00**

SOFTY II INTELLIGENT PROGRAMMER

The complete micro processor development system for Engineers and Hobbyists. You can develop programs, debug, verify and commit to EPROMS or use in host computer by using softy as a romulator. Powerful editing facilities permit bytes, blocks of bytes changed, deleted or inserted and memory contents can be observed on ordinary TV.
Accepts most +5 V EPROMS
Softy II complete with PSU, TV Lead and Romulator lead .... **£ 169**

RUGBY ATOMIC CLOCK

This Z80 micro controlled clock/calendar receives coded time data from NPL Rugby. The clock never needs to be reset. The facilities include 8 independent alarms and for each alarm there is a choice of melody or alternatively these can be used for electrical switching. A separate timer allows recording of up to 240 lap times without interrupting the count. Expansion facilities provided.

Complete Kit	**£ 120** + £ 2.00 carr.
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Reprint of ETI articles at £ 1.00 + s.a.e.

ACORN ATOM

Basic Built	£ 135
Expanded	£ 175

(carr £ 3/unit)

Atom Disc Pack **£ 299** + £ 6 carr
3 A 5 V Regulated PSU **£ 26** + £ 2 carr
Full Range of Atomsoft in stock. Phone or send for our BBC Atom list.

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RGB Input 18MHz Bandwidth
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SPECIAL OFFER to Elektor readers

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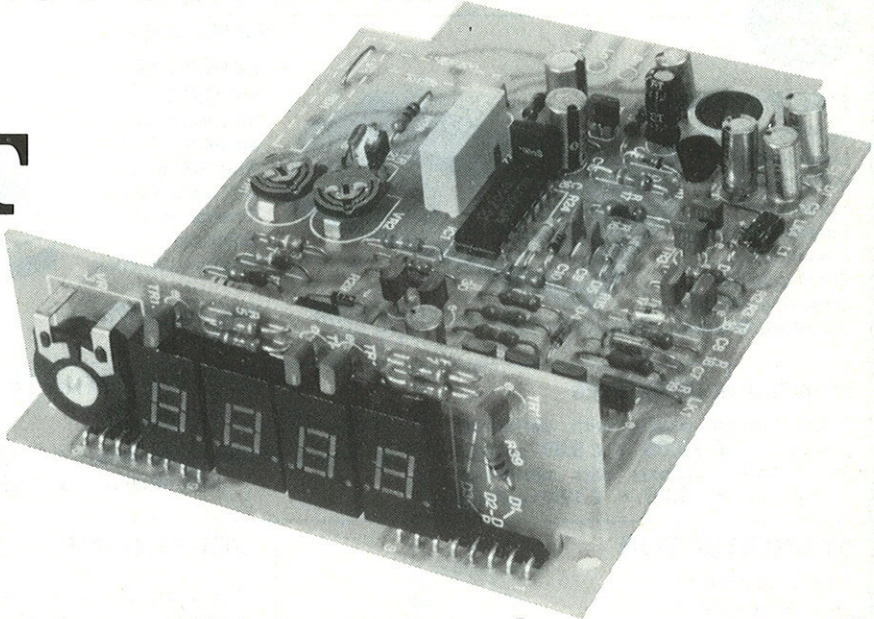
3½ DIGIT LED PANEL METER



for only £11.95 + 75p P&P (inc.VAT)

The DP 355 is a 3½ digit LED panel meter with a full scale input of ± 1.999 V D.C., and a basic accuracy of 0.5%. It has a very high input impedance (> 1 GΩ) and good linearity, typically 0.1%. The whole instrument operates from a single 5 volt rail. Polarity and overload indication are automatically displayed.
There is provision on the pcb to fit either attenuator resistors to alter the input voltage for full scale or shunt resistors for current measurement. The decimal points are user programmable to correspond to the full scale voltage/current. Full specifications and applications for use are included.

Don't miss this excellent offer closing date-31st Dec. 1982
Only a limited number of meters are available,
so order now while stocks last.
Complete the coupon below and mail it,
with your cheque or postal order,
to Elektor Publishers Ltd., 10Longport, Canterbury, Kent CT1 1PE.
Please allow 28 days for delivery.

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I enclose cheque/P.O. for (payable to Elektor Publishers Ltd.)
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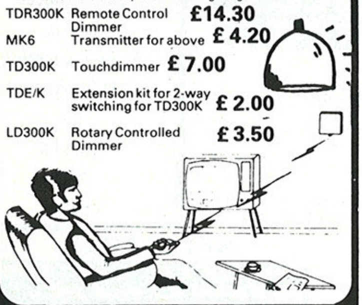
E1282

HOME LIGHTING KITS

These kits contain all necessary components and full instructions & are designed to replace a standard wall switch and control up to 300w. of lighting.

TDR300K	Remote Control Dimmer	£14.30
MK6	Transmitter for above	£ 4.20
TD300K	Touchdimmer	£ 7.00
TDE/K	Extension kit for 2-way switching for TD300K	£ 2.00
LD300K	Rotary Controlled Dimmer	£ 3.50



HOME CONTROL CENTRE

This New Remote Control Kit enables you to control up to 16 different appliances anywhere in the house from the comfort of your armchair. The transmitter injects coded pulses into the mains wiring which are received by receiver modules connected to the same mains supply and used to switch on the appliance addressed. Receivers are addressed by means of a 16-way keyboard, followed by an on or off command. Since pushing buttons can become rather boring, the transmitter also includes a computer interface so you can programme your favourite micro to switch lights, heating, electric blanket, make your coffee in the morning, etc., without rewiring your house. JUST THINK OF THE POSSIBILITIES. The KIT includes all PCBs and components for one transmitter and two receivers, plus a drilled box for the transmitter.

Order as XK112. **£42.00**

Additional Recievers XK111 £10.00

ELECTRONIC LOCK KIT XK101

This KIT contains a purpose designed lock IC, 10-way keyboard, PCBs and all components to construct a Digital Lock, requiring a 4-key sequence to open and providing over 5000 different combinations. The open sequence may be easily changed by means of a prewired plug. Size: 7 x 6 x 3 cms. Supply: 5V to 15 V d.c. at 40uA. Ouput: 750mA max. Hundreds of uses for doors and garages, car anti-theft device, electronic equipment, etc. Will drive most relays direct. Full instructions supplied.

ONLY £10.50

Electric lock mechanism for use with latch locks and above kit.

£13.50

CHRISTMAS PRESENTS GALORE

3-NOTE DOOR CHIME

Based on the SAB0600 IC the kit is suppied with all components, including loudspeaker, printed circuit board, a pre-drilled box (95 x 71 x 35mm) and full instructions. Requires only a PP3 9V battery and push-switch to complete. AN IDEAL PROJECT FOR BEGINNERS. Order as XK102. **£5.00**

LIGHT DIMMER KIT

Contains all components, including front panel and knob, to make a dimmer for lights up to 300W. **£3.50**

MW RADIO KIT

Based on ZN414 IC, kit includes PCB, wound aerial and crystal earpiece and all components to make a sensitive miniature radio. Size: 5. 5 x 2. 7 x 2 cms. Requires PP3 9V battery. IDEAL FOR BEGINNERS. **£5.00**

LCD 3½ DIGIT MULTIMETER

16 ranges including DC voltage (200 mv-1000 v) and AC voltage, DC current (200 mA-10 A) and resistance (0-2 M) + NPN & PNP transistor gain and diode check. Input impedance 10M. Size 155x88x31 mm. Requires PP3 9v battery. Test leads included **ONLY £29.00**

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PACK (1) 650 Resistors 47 ohm to 10 Mohm - 10 per value £4.00
PACK (2) 40 x 16V Electrolytic Capacitors 10uF to 1000uF - 5 per value £3.25
PACK (3) 60 Polyester Capacitors 0.01 to 1uF/250V - 5 per value £5.55
PACK (4) 45 Sub-miniature Presets 100 ohm to 1 Mohm - 5 per value £2.90
PACK (5) 30 Low Profile IC Sockets 8, 14 and 16 - pin - 10 off each £2.40
PACK (6) 25 Red LEDs (5mm dia.) £1.25
PACK (7) 20 BC182 NPN General Purpose Transistors £1.20
PACK (8) 20 BC212 PNP General Purpose Transistors £1.20

All full spec. branded devices

BUY ANY 5 PACKS AND WE WILL SEND YOU 10 RED LEDs FREE

ALL PRICES EXCLUDE VAT

DVM/ULTRA SENSITIVE THERMOMETER KIT

This new design is based on the ICL7126 (a lower power version of the ICL7106 chip) and a 3½ digit liquid crystal display. This kit will form the basis of a digital multimeter (only a few additional resistors and switches are required—details supplied), or a sensitive digital thermometer (−50°C to +150°C) reading to 0.1°C. The basic kit has a sensitivity of 200mV for a full scale reading, automatic polarity indication and an ultra low power requirement—giving a 2 year typical battery life from a standard 9V PP3 when used 8 hours a day, 7 days a week.

Price £15.50

DISCO LIGHTING KITS

DL 1000K

This value-for-money kit features a bi-directional sequence, speed of sequence and frequency of direction change, being variable by means of potentiometers and incorporates a master dimming control. **£14.60**

DLZ100K

A lower cost version of the above, featuring undirectional channel sequence with speed variable by means of a pre-set pot. Outputs switched only at mains zero crossing points to reduce radio interference to a minimum. **Only £8.00**

Optional opto input DLA1
Allowing audio ("beat") —light response. **60p**

DL3000K

This 3 channel sound to light kit features zero voltage switching, automatic level control & built in mic. No connections to speaker or amp required. No knobs to adjust – simply connect to mains supply & lamps. (1Kw/Channel) **Only £11.95**

"OPEN-SESAME"

The XK103 is a general purpose infra-red transmitter/receiver with one momentary (normally open) relay contact and two latched transistor output. Designed primarily for controlling motorised garage doors and two auxillary outputs for drive/garage lights at a range of up to 40 ft. The unit also has numerous applications in the home for switching lights, TV, closing curtains, etc. Ideal for aged or disabled persons.

The Kit comprises a mains powered receiver, a four button transmitter, complete with predrilled box, requiring a 9V battery and one opto-isolated solid state switch kit for interfacing the receiver to mains appliances. As with all our kits, full instructions are supplied.

ONLY £23.75

REMOTE CONTROL KITS

MK6 SIMPLE INFRA RED TRANSMITTER
Pulsed infra red source complete with hand-held plastic box. Requires a 9V battery **£4.20**

MK7 INFRA RED RECEIVER
Single channel, range approx. 20ft. Mains powered with a triac output to switch loads up to 500W at 240V ac. **£9.00** (RC500K –Special Price for MK6 and MK7 together **£12.50**

MK8 CODED INFRA RED TRANSMITTER
Based on the SL490, the kit includes all components to make a coded transmitter and only requires a 9V (PP3) battery and keyboard. 8 x 2 x 1.3cms **£5.90**

MK10 16-WAY KEYBOARD
For use with MK8 and MK18 to generate 16 different codes for decoding by the ML928 or ML926 receiver (MK12) kit. **£5.40**

MK11 10-Channel + 3 Analogue o/p IR Receiver
Based on ML922 decoder IC. Functions include on/standby output, toggle, control of volume, tone and lamp brightness. Includes its own mains supply. **£12.00**

MK12 16-CHANNEL IR RECEIVER
For use with MK8 kit with 16 on/off outputs, which with further interface circuitry, such as relays or triacs, will switch up to 16 items of equipment on or off remotely. Latched or momentary outputs – please specify when ordering. Includes its own mains supply. **£11.95**

MK13 11-WAY KEYBOARD For use with MK8, MK18 and MK11 kits. **£4.35**

MK16 Mains Powered IR Transmitter
Mains powered for continuous operation – single channel, for applications such as burglar alarms, automatic door openers, etc. Range approx. 6 ft. **£2.50**

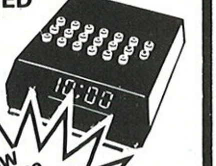
MK17 12V d.c. IR RECEIVER
For use with MK6 or MK16. Relay output with DP 3 Amp change-over contacts, may be used as latched, momentary or "break beam" receiver. Operates from 6-13V d.c. **£9.50**

MK18 HIGH POWER IR TRANSMITTER
Similar to MK8 but with range of approx. 60ft. **£6.20**

Ancillary Kits : MK2 Solid State Relay
Opto-isolated with zero voltage switching. No. triac supplied. **£2.60**

MK15 DUAL LATCHED SOLID STATE RELAY
Comprises 2 x solid state relays and latch for use with momentary version of the MK12. 2 output triacs required (not supplied). **£4.50**

THE MULTI-PURPOSE TIMER HAS ARRIVED



Now you can run your central heating, lighting, hi-fi system and lots more with just one programmable timer. At your selection it is designed to control four mains outputs independently, switching on and off at pre-set times over a 7 day cycle, e.g. to control your central heating (including different switching times for weekends), just connect it to your system programme and set it and forget it—the clock will do the rest.

FEATURES INCLUDE:-

- 0.5" LED 12 hour display.
- Day of week, am/pm and output status indicators.
- 4 zero voltage switched mains outputs.
- 50/60Hz mains operation.
- Battery backup saves stored programmes and continues time keeping during power failures. (Battery not supplied).
- Display blanking during power failure to conserve battery power.
- 18 programme time sets.
- Powerful "Everyday" function enabling output to switch every day but use only one time set.
- Useful "sleep" function–turns on output for one hour.
- Direct switch control enabling output to be turned on immediately or after a specified time interval.
- 20 function keypad for programme entry.
- Programme verification at the touch of a button.

NOW ONLY £39 WITH SO MANY EXTRA FEATURES. OPTIONAL BLACK PLASTIC CASE. READY DRILLED £2.50

(Kit includes all components, PCB, assembly and programming instructions). ORDER AS CT5000

24 HOUR CLOCK/APPLIANCE TIMER KIT

Switches any appliance up to 1kW on and off at present times once per day. Kit contains: AY-5-1230 IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triacs, PCBs and full instructions.

CT1000K Basic Kit £14.90
CT1000K with white box (56/131 x 71mm) £17.40
(Ready Built) £22.50

FREE **SHORT FORM CATALOGUE** – send SAE (6" x 9"). We also stock Vero, Books, Resistors, Capacitors, Semi-Conductors etc.

Add 55p postage & packing +15% VAT to total.
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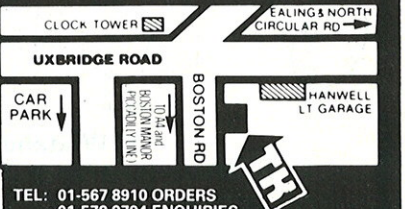
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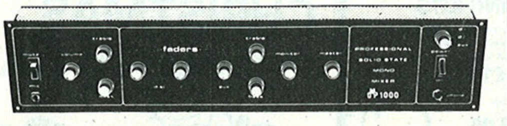
MULLARD SPEAKER KITS

A PURPOSELY DESIGNED 40 WATT R.M.S. 8 OHM SPEAKER SYSTEM RECENTLY DEVELOPED BY **MULLARD'S** SPECIALIST TEAM IN BELGIUM. Kit comprises a **Mullard** 8" Woofer with foam surround and aluminium voice coil. **Mullard** 3" high power dome tweeter. **B.K.E.** built and tested crossover, based on Mullard circuit combining low loss components, glass fibre board and recessed loudspeaker terminals. Recommended cabinet size 240 × 216 × 445 mm.
A superb sound at a relatively low cost. Complete with instructions. Price **£14.90 + £1.50 p&p per kit.**

New 5" 30 watt mini version of above now available.
Recommended cabinet size 180 × 155 × 295mm

Price **£13.90 + £1.00 p&p per kit.**



1000 MONO DISCO MIXER

A superb **fully built and tested** mixer/pre-amp with integral power supply. 4 **Inputs** 2 turntables (ceramic cartridge). Aux. for tape deck etc., plus Mic. with override switch, all with individual level controls. Two sets of active tone controls (bass and treble) for Mic. and main inputs. Master volume control. Monitor output with select switch and volune control.

Outputs Main 750 mV Monitor 500 mW into 8 ohms. **Supply** 220/240V AC50/60Hz
Size 22½" × 4⅞" × 2½"
price £39.99 + £2.50 P&P

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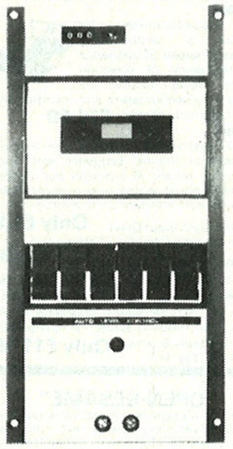
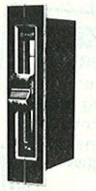


6 piano type keys

STEREO CASSETTE TAPE DECK MODULE.

Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested.
Features: Three digit tape counter. Autostop. Six piano type keys, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. **Input Sensitivity:** 100mV to 2V **Input Impedance:** 68K. **Output level:** 400mV to both left and right hand channels. **Output Impedance:** 10K. **Signal to noise ratio:** 45dB. **Wow and flutter:** 0.1%. **Power Supply requirements:** 18V DC at 300mA. **Connections:** The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided). **Dimensions:** Top panel 5½in x 11¼in. Clearance required under top panel 2¼in. Supplied complete with circuit diagram and connecting diagram. Attractive black and silver finish.
Price £26.70 + £2.50 postage and packing.
Supplementary parts for 18V D.C. power supply (transformer, bridge rectifier and smoothing capacitor) **£3.50.**

1K.WATT SLIDE DIMMER



- Controls loads up to 1KW
- Compact size $4\frac{3}{4}'' \times \frac{13}{16}'' \times 2\frac{1}{2}''$
- Easy snap in fixing through panel/cabinet cut out
- Insulated plastic case
- Full wave control using 8amp triac
- Conforms to BS800
- Suitable for both resistance and inductive loads

Innumerable applications in industry, the home, and discos/theatres etc.

Price: **£11.70** each + **50p** P&P
(Any quantity)

KEYBOARDS

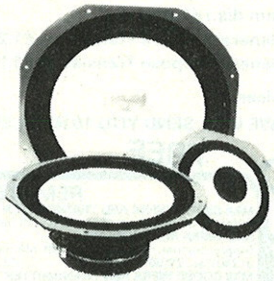
MEMBRANE KEYBOARDS manufactured from a tough polycarbonate film mounted on 1mm glass fibre printed circuit board assembly incorporating silver plated contacts.
16 way numeric keyboard Standard keyboard providing 0-9 and A-F functions.
Size: 100mm × 100mm Price: **£5.99 + 35p p&p**

Alpha Numeric Keyboard Full size 55 key non encoded keyboard with the commonly required functions in a Qwerty array. Matrix output via a 16 pin DIL socket.
Size: 350mm × 102mm Price: **£13.99 + 50p p&p**

BSR P256 TURNTABLE

P256 turntable chassis ● S shaped tone arm ● Belt driven ● Aluminium platter ● Precision calibrated counter balance ● Anti skate (bias device) ● Damped cueing lever ● 240 volt AC operation (Hz) ● Cut out template supplied ● Completely manual arm. This deck has a completely manual arm and is designed primarily for disco and studio use where all the advantages of a manual arm are required.
Price: **£28.50** + £2.50 P&P

NEW RANGE QUALITY POWER LOUDSPEAKERS (15", 12" and 8"). These loudspeakers are ideal for both hi-fi and disco applications. Both the 12" and 15" units have heavy duty die-cast chassis and aluminium centre domes. All three units have white speaker cones and are fitted with attractive cast aluminium (ground finish) fixing escutcheons.
Specification and Price: –

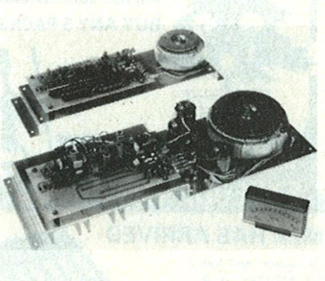


15" 100 watt R.M.S. Impedance 8ohm 59 oz. magnet, 2" aluminium voice coil. Resonant Frequency 20Hz. Frequency Response to 2.5KHz. Sensitivity 97dB. **Price £32 each** £3.00 Packing and Carriage each.

12" 100 watt R.M.S. Impedance 8 ohm, 50 oz magnet. 2" aluminium voice coil. Resonant Frequency 25Hz. Frequency Response to 4KHz. Sensitivity 95dB. **Price £23.70 each.** £3.00 Packing and Carriage each.

8" 50 watt R.M.S. Impedance 8 ohms, 20 oz. 1½" aluminium voice coil, Resonant Frequency 40Hz, Frequency Response to 6KHz, Sensitivity 92dB. Also available with black cone fitted with black metal protective grill. **Price: White cone £8.90 each. Black cone/grill £9.50 each.** P & P £1.25 each.

POWER AMPLIFIER MODULES



100 WATT R.M.S. AND 300 WATT R.M.S. MODULES

Power Amplifier Modules with integral toroidal transformer power supply, and heat sink. Supplied as one complete built and tested unit. Can be fitted in minutes. An LED Vu meter is available as an optional extra.

SPECIFICATION:
Max Output Power: 110 watts R.M.S. (OMP 100)
310 watts R.M.S. (OMP 300)
Loads: Open and short circuit proof. 4-16 ohms.
Frequency Response: 20Hz – 25KHz ±3dB.
Sensitivity for Max. Output:
500mV at 10K (OMP 100) 1V at 10K (OMP 300)
T.H.D.: Less than 0.1%
Supply: 240V 50Hz
Sizes: OMP 100 360 × 115 × 72mm
OMP 300 460 × 153 × 66mm
Prices: OMP 110 **£31.50 each + £2.00 P&P**
OMP 300 **£89.00 each + £3.00 P&P**
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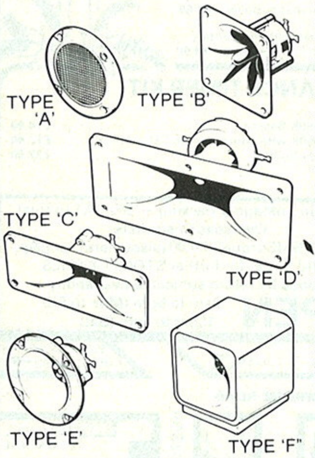

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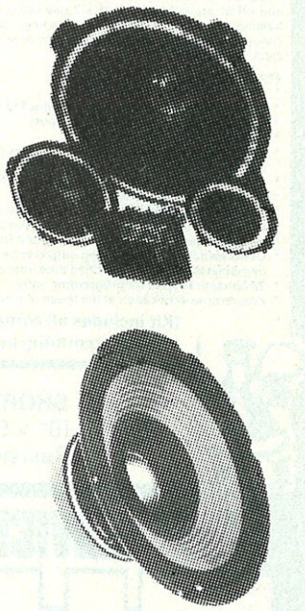

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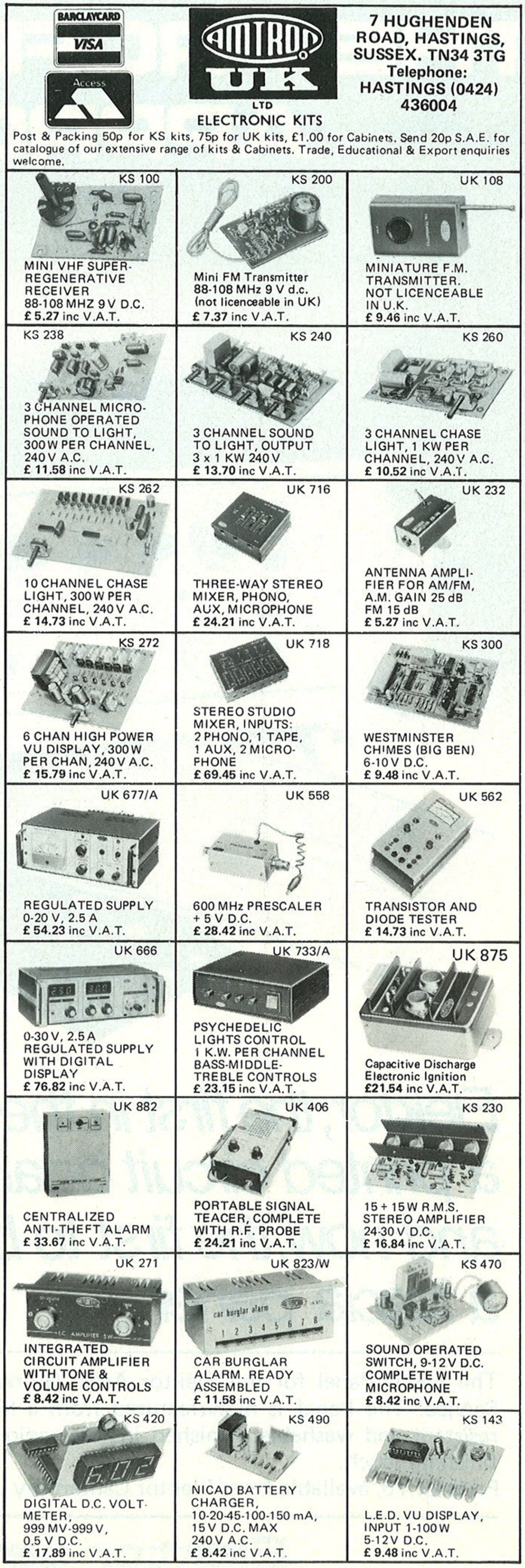

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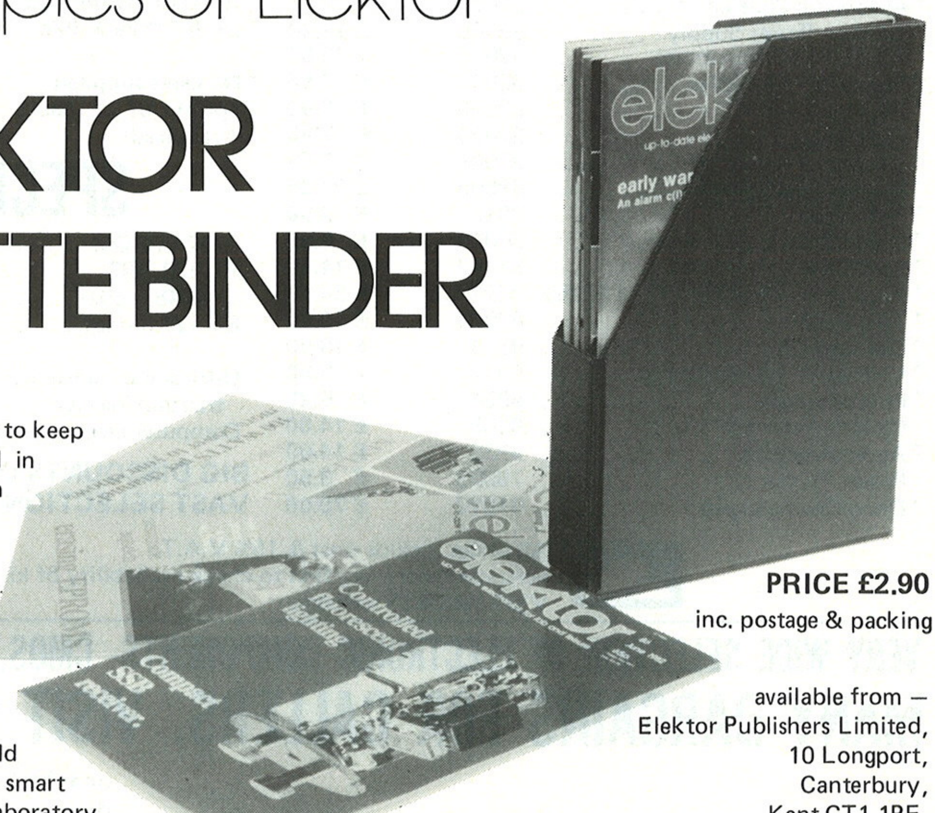

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solid-state gyros . . .

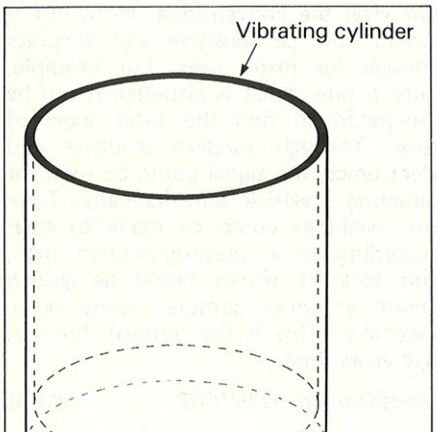
Conventional gyros have to be accurately machined and are very expensive. Moreover, they are delicate mechanisms vulnerable to shock or vibration. Far more robust and cheap to produce is a new device based on a cylinder's flexural mode of vibration and the effect of Coriolis force.

Imagine a fleet of fork-lift trucks moving about a warehouse or factory, following precisely the routes they are instructed to take and automatically correcting any error in direction, but all without drivers. This is but one application foreseen for a novel device with a diameter of only 17 mm and 25 mm long.

The device can be called variously a solid-state gyro or a rate gyro or a rate sensor. It was invented and is being developed by GEC Marconi Electronics at its research laboratories at Great Baddow in eastern England. The scientist concerned who demonstrated the device recently to members of the Royal Society in London is Dr R. M. Langdon, who has used the three different names and has researched the subject for a couple of years.

The word gyro could perhaps be a little misleading because of our preconceptions. We know that it is a wheel or disc or cylinder rotating at a very high speed and often mounted in a complete set of gimbals. Simple gyros have been sold as toys, but the complete mathematical behaviour of such a device is far from simple (it involves vector analysis) and need not be considered here.

Basic shape of the solid-state gyro.



Gyros have had and still have many successful uses, for example as compasses for navigation, in stabilizers for ships, in monorail vehicles, and so on, apart from military applications. These are the gyros we are familiar with, but the new Marconi device is quite different. For one thing it has no heavy, fast-rotating wheel or cylinder driven by a motor. It has no bearings in which anything moves. Yet it can do what many conventional gyros can do. That is why it is often called a gyro. It measures the rate of rotation of any vehicle in which it is mounted, so it is of the type known as a rate gyro.

Virtually indestructible

The reason for the search for newer devices to do most of the things that mechanical gyros do it that the latter are very expensive: their machining has to be extremely accurate so that there is negligible friction and no imbalance. So the gyros that are used for such tasks as navigation are very expensive — the smallest may cost as much as £ 1000. Furthermore, they are vulnerable to severe shock or vibration. A much cheaper device to do the same job yet be so robust that it is virtually indestructible is obviously a desirable product with a big potential market.

Several scientists and engineers have used their skills to invent such new devices, relying on periodic vibrations instead of mechanical rotation. The earliest was a tuning-fork mounted vertically, its stem being of such dimensions that any torsional vibration would be of the same frequency as that of the tines. When the whole fork was rotated, the torsional vibration set up was measured and was proportional to the rate at which the fork was rotating. It was in effect a rate gyro.

Other devices have utilized vibrating wires or rods, but little is known about them. As for the tuning-fork device, despite intensive work in the USA and at the Royal Aircraft Establishment in Britain, it has not come into production, presumably because of the complexity needed for a satisfactory instrument and the cost of careful machining.

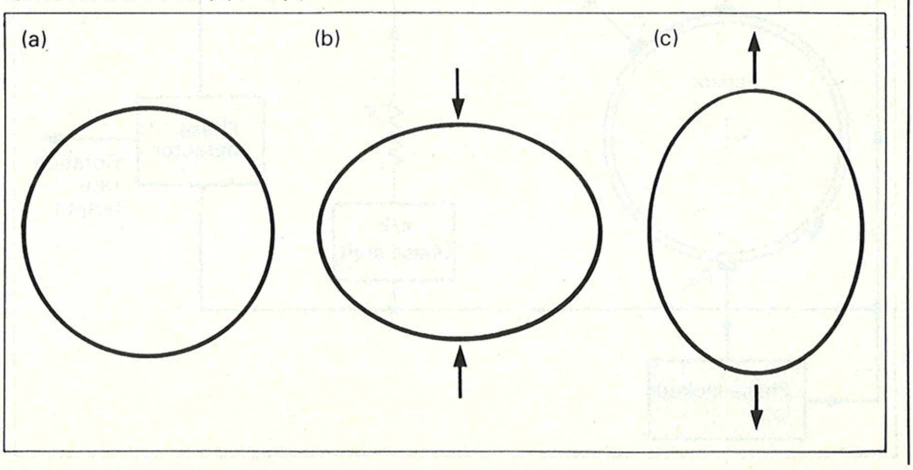
Coriolis force

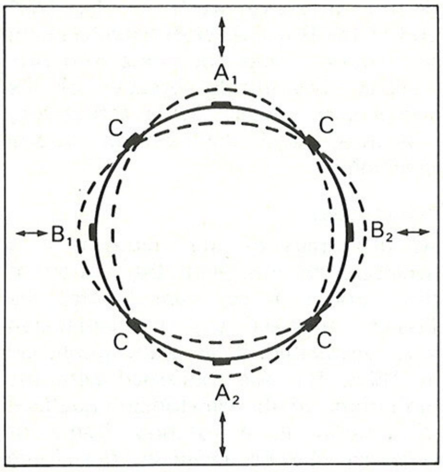
At this stage of the argument it is necessary to introduce the notion of the Coriolis force, named after the French engineer and mathematician who postulated it in work published in 1835. He was concerned with the limitations of the Newtonian equations of motion in a rotating frame of reference. So he added another force in such a system, and when he did so the Newtonian equations could be used. (Physicists and mathematicians spent about a century searching for an 'absolute' frame of reference only to find that they were chasing a will-o'-the-wisp, so a radical change of approach was needed, culminating in Einstein's Relativity Theory.)

Early use of the Coriolis-force Idea was in calculations of ballistic trajectories, because the Earth is a rotating body. Oceanologists and meteorologists have invoked the Coriolis force to account for ocean and air motions. More recently scientists have used it in connection with rotating systems such as gyros.

It is the Coriolis force that comes into the explanation of how the Marconi device behaves. Basically, the device is a cylinder of metal, so asymmetric difficulty is avoided. It looks somewhat like a wine-glass, and everyone knows that is such as glass is struck near the rim it emits a ringing sound, just as a bell does. The fundamental frequency of the tone it gives off depends on the dimensions and the elastic modulus of the material. If we could observe it from above, the vibrations would be seen as shown, grossly exaggerated, in the diagrams a, b and c. So the first problem is how to produce and maintain the vibration. This is done by means of piezoelectric crystals. Such a crystal will produce a vibratory motion in response to an applied oscillatory

Flexural vibration of the cylindrical cross-section, shown undistorted (a) and subjected to forces as indicated in (b) and (c).





Superimposing the distortions caused by flexural vibration, produced by applying an oscillatory voltage to transducers at A_1 and A_2, shows that nodes appear at points marked C. Other transducers at B_1 and B_2 serve as sensors to pick up the movement and convert it back into an alternating electrical signal.

electrical signal; conversely, it produces an oscillating current when made to vibrate physically. Moreover, it can be made very thin and small.

In the combined diagram, the three parts of the previous diagram are superimposed, with piezoelectric crystals mounted as shown at A_1 and A_2 and at right angles at B_1 and B_2. The oscillatory circuit is connected to A_1 and A_2 while B_1 and B_2 are used as sensors to pick up the mechanical movement and convert it into electrical alternations. There are also piezoelectric crystals quipositioned between the As and Bs, and it can be seen that when the cylinder is stationary there is a node at each position marked C. That is to say, there is no movement of the cylinder wall at those places, so there is no electrical output from the C crystals. The symmetrical way the crystals are arranged helps maintain the overall symmetry.

In practice there are various electronic circuits connected to several of the crystals, but we need not go into the detail. Some of the circuits maintain the frequency, others effect corrections, and so on.

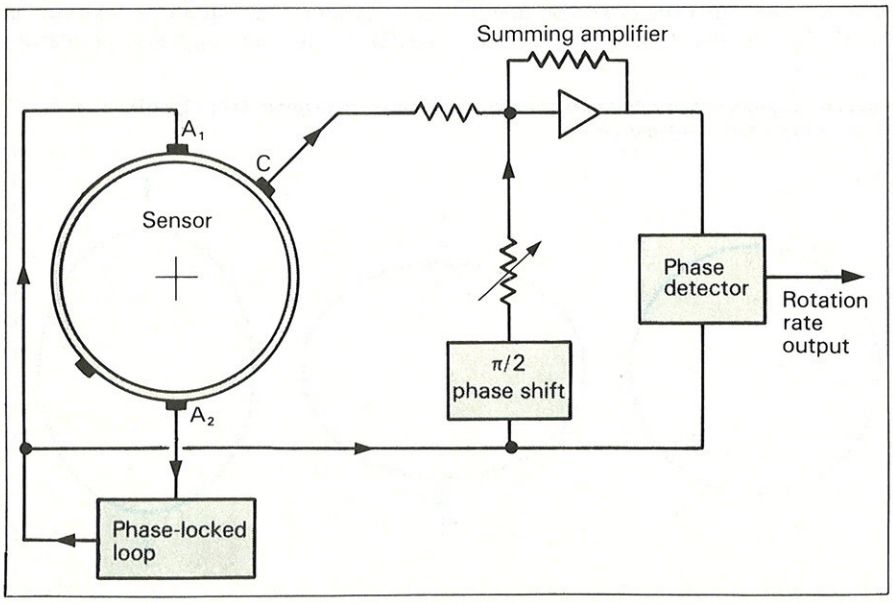
Distorting force

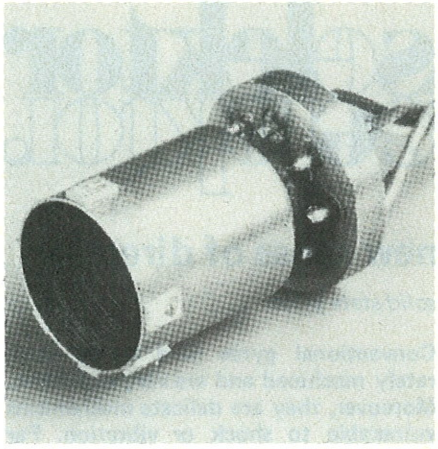
Now let us suppose that the cylinder rotates about its central longitudinal axis. Immediately, the Coriolis force comes into play. The effect is to add a tangential force to the force along the diameter of the cylinder, that is, the force direction for the vibration. As a result there is distortion of the movement and the points marked C are no longer nodes; instead, there is some movement outwards and inwards. This is sensed by the transducers at C and can be measured electronically. The amplitude of the electrical signal so produced is directly proportional to the rate of rotation. When the signal is rectified, and thereby changed into a direct-current signal, its strength can be shown on a meter which, when suitably calibrated, gives a direct reading of the rotation rate.

This sounds simple enough, but a great deal has been left out of the explanation in order to keep it readily understandable. For example, it is not easy to find the exact point where there is a node, so two transducers may be needed, with subsequent electronic treatment. To overcome the difficulty, a better method of measurement has been used. A signal that is 90 degrees out of phase with the input signal at A_1 is added to the output from C. Fairly simple mathematics then shows that the signal to be used is shifted in phase and that the shift is directly proportinal to the rate of rotation. With this technique there is greater sensitivity.

Such a device must be inside a cylindrical cover for protection. The first, made for investigation, had an overall length of 85 mm and a diameter of 50 mm. It was made of brass and had a fundamental vibration frequency of about 3 kHz. Many experiments were done with it to discover the next practical steps necessary in the research and development. For example, would temperature affect the performance? What adhesive would be best both for adhesion and electrical conductivity to the metal? How much would the distance between active cylinder and the surrounding cover affect the accuracy? Many such questions affecting the accuracy, stability, sensitivity, ease of manufacture, and so on were raised for continued investigation. And what about miniaturization? A much smaller one was made and it worked satisfactorily. It was that version which was shown recently in London.

Sensor circuit arrangement for variable-phase output.





Miniature version of the rate sensor, measuring 25 mm x 17 mm.

So the correctness of the basic assumptions has been proved, and the company has been careful about worldwide patents. However, there is still a lot to be done and it will be a few years before there will be a product suitable for marketing.

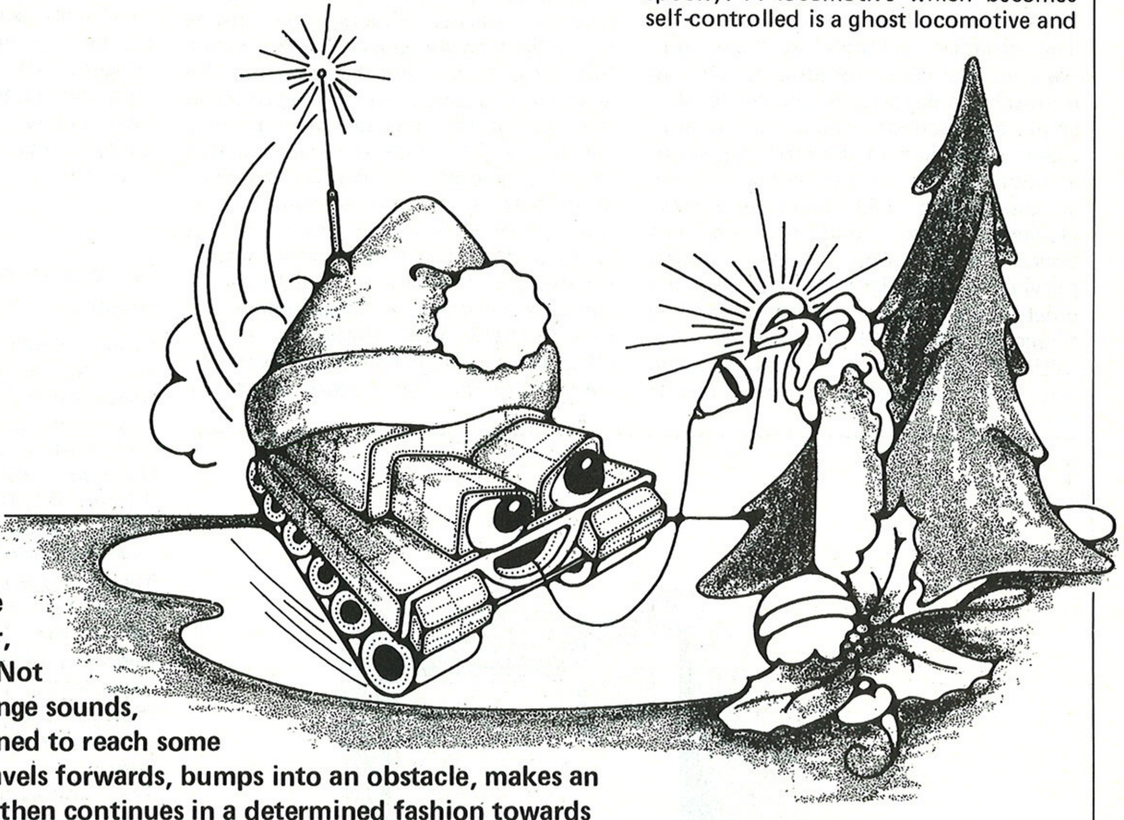
The device is indestructible and unaffected by shock or vibration, and it would be inexpensive to produce. For the most delicate applications it would not rival the conventional gyro, but it would still be sensitive and accurate enough for many uses. For example, once a rate signal is obtained it can be integrated to find the total angle of turn. Through modern electrics and electronics, the signal could be used for directing a vehicle automatically. Tractor machines could be made to steer according to a preprogrammed plan, and fork-lift trucks could be guided about a works complex quite automatically. This is the outlook for say, five years time.

Spectrum, no. 180/1982 (833 S)

triopede

Tripodus Electrus Diclopus (TED) . . .

J. Cornelissen



People will be astonished to see this three-wheeled creature moving along the floor, buzzing and chirping. Not only does it make strange sounds, but it appears determined to reach some destination. First it travels forwards, bumps into an obstacle, makes an elegant reverse U-turn then continues in a determined fashion towards some invisible destination. After careful observation of its behaviour, the only conclusion that can be drawn is that the creature is a light-addict!

Hence the name Triopodus Electrus Diclopus, or TED for short. In normal terms it means: a light seeking, three wheeled, electro-mechanical hybrid.

The built-in electronic instinct is programmed to seek the brightest point in the room. A deviation routine in the logic circuit ensures that it cleverly avoids the many obstacles on its path towards the light.

For specialists it is clearly a simple cybernetic model. But to other, unbiased observers it is a spectacular electronic monster. For domestic pets it is a strange encounter of the third kind. For electronic hobbyists it is a lot of fun.

When a technical creation becomes self-controlled it usually appears monstrous to us humans. Inanimate objects are supposed to be 'dead' and independent action is associated with living beings. Exceptions to this rule are spooky. A locomotive which becomes self-controlled is a ghost locomotive and when inanimate objects move without being instructed to do so it is eery. This is what we are dealing with here. It is small, a bit weird but a lot of fun.

Action and reaction

As in the case of a living being, TED requires an internal locomotor system. It is driven by two electric motors that draw their energy from a rechargeable battery. The locomotor system is completed by three wheels. Another characteristic of living beings is the ability to react in a specific manner to external stimulus. This results in a behavioural pattern. Our TED is equipped with simple sensory organs: two light-sensitive cells consisting of light-dependent resistors provide the electronic creature with directional, light-seeking behaviour. Simple contacts allow it to detect obstacles.

The two eyes (hence diclopus) are fitted at the front at an adequate distance from each other; they contain LDRs. If the light impinges laterally, then one of the two LDRs is subjected to less light than the other. The result is that the motor's electronic control circuitry executes a change of course which lasts until the light impinges from the front and both LDRs are subjected to the same amount of light.

If there is only one light source in a room with dark walls, our monster will always travel towards this light source. The direction it faced when it was placed on the floor is immaterial (figure 1). There is, however, one exception: when travelling away from the light source, no direct light impinges on the LDRs. Both are dark and TED will travel aimlessly into the darkness.

The situation is somewhat more complex in daylight conditions. On an infinitely large area subjected to sunshine, our stubborn electronic creature would travel east in the morning, south at noon and west in the evening, as long as the battery still delivered energy. However, these conditions do not prevail in a room; several windows provide several light sources and the creature must select one of them. The direction of travel depends on the initial direction when it was switched on. There are often strange results which cannot be foreseen in the development stage: when faced with a 'difficult decision' the entire system of the creature can start oscillating; this is made noticeable by the creature swinging to and fro on the spot as though it cannot make up its mind. This phenomenon is occasionally encountered in more intelligent beings! The problem was largely solved, however, by an appropriate modification to the circuitry.

Since most windows do not extend down to the floor, the cybernetic creature often changes direction when approaching a window: when it enters the shade area it may suddenly detect a light object that was previously undetected on account of the bright light from the window. Instead of continuing its journey towards the wall, the creature changes direction and heads for a light waste-paper basket. During this turn, it can also happen that the light from another window appears in the view of TED and becomes the new destination. The creature is even capable of avoiding obstacles. An object placed in its path, such as a carboard box or waste-paper basket or even a human, is avoided if — and this is important — the object is in front of the light source and appears darker than the background to the LDR eyes (figure 2). If the obstacle has a light colour and is illuminated from the side towards which the creature is travelling, it is immediately attacked. Even the light-coloured trousers of Elektor staff members were not spared.

On the other hand, the legs of chairs and tables are not detected. The creature can 'see' about as much as a human who tries to walk towards a light window with his eyes closed. Two sensor contacts are interconnected by means of a bracket which forms a kind of 'front bumper'; this informs the creature when it has bumped into an undetected obstacle. When the bumper touches an object the creature's 'vision' is briefly disabled and it executes an 'instinctive action'. It reverses for a short distance (to obtain sufficient space for a change in direction) then makes a turn to the left or right, depending on the location of the obstacle. Luckily, our electronic creature is not capable of intelligent thought. Its creators wisely refrained from providing it with a computer brain and merely made use of simple and easily constructed, hard-wired logic circuitry.

1

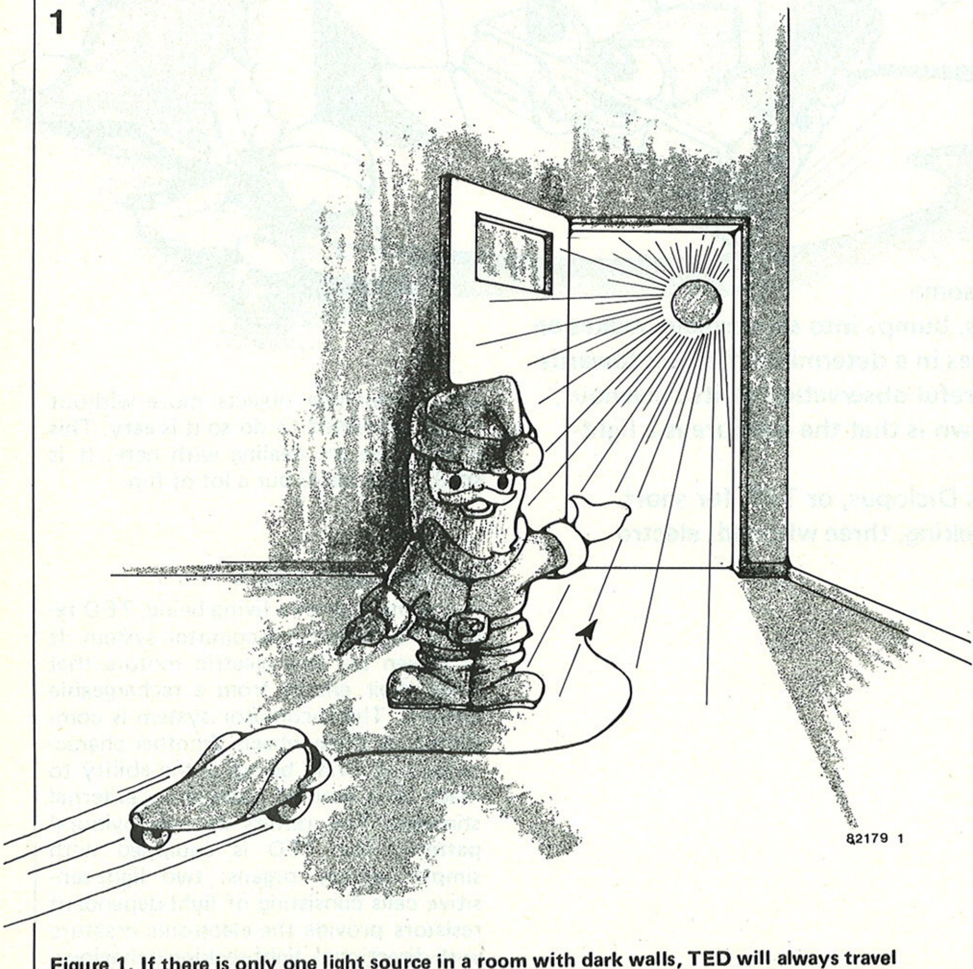


Figure 1. If there is only one light source in a room with dark walls, TED will always travel towards this light source. The direction it faced when placed on the floor is immaterial.

The circuit or simple nervous system

From the electronic viewpoint TED is a fairly simple creature: it has simple sensors, simple logic circuitry and simple drives. Let us consider the sensors first. The most important sensory organs are the two LDRs which form a potential divider (R1, R2). When subjected to the same amount of light the two LDRs have the same resistance; half the operating voltage is then applied to the midpoint. Two triggers without hysteresis ensure that any deviation from this midpoint results in a binary signal for 'right/left'. The two LEDs D3/D4 indicate the initial state and are indispensable for alignment, as described later.

The following memory stage IC2 prevents direct feedback from the drive (direction control) to the direction indicators (LDRs). If the LDRs were to control the drive motors directly, hunting or oscillating could easily occur. In order to avoid such nervous overreactions the creature was given a 'tranquilliser' in the form of IC2. This ensures that the results of its sensory perception are passed on with a slight delay, whenever clock generator A3 emits a pulse. TED blinks, so to speak, at the rhythm of the clock generator. LED D5 also flashes with each clock pulse, to make the blinking noticeable.

Direction control and drive are interrelated: this is an integrated function of the type used by track-laying vehicles. Each of the two drive wheels has its own motor and each motor has its own control system. When the directions of rotation are in opposition the TED turns on its own axis. When the directions of rotation are the same it travels forwards or backwards, depending on the polarity of the motor supply. A bridge circuit of four transistors for each motor caters for polarity inversion. Driving of the bridge output stages is simply performed by inverting CMOS buffers (N17 . . . N20). Since the motors are controlled digitally and not proportionally, the power loss is very low. As much of the battery energy as possible is made available for the drive system.

So that TED will not 'give up the ghost' in front of every obstacle, the circuitry contains a deviation logic circuit. A front bumper is mounted on two sensors that require only slight pressure for actuation. When an obstacle is bumped into, these sensors deliver a logic '0' to the inputs of the flip-flop consisting of the two NAND gates N1 and N2, and to the inputs of gate N3. N3 represents an OR-function for the sensor signals: as soon as a sensor is actuated by a collision, N3 delivers a pulse to the two monostables N13/N14 and N15/N16. The duration of the toggled state of N15/N16 is about twice as long as that of N13/N14. The shorter time governs the duration of reverse travel and the longer time governs the total duration of the avoiding action. The whole operation consists of reverse travel of about one length of the creature, followed by a 90° turn.

In the event of a reaction to light (no collision) pin 9 of N9 and pin 5 of N10 are at logic '1'. The information from the latch is allowed to pass. At the following OR-gates N7 and N8, pin 13 (N7) and pin 1 (N8) are at logic '0'. This means that only the 'visual' information is allowed to pass here also (logic signals at the outputs of N9 and N10). When an obstacle is bumped into, both monostable outputs (pin 4 of N14 and pin 10 of N16) are first at logic '1'. This causes pin 3 of N4 to go to logic '0'; N9 and N10 are inhibited. The outputs of N7 and N8 are now at logic '1' until the monostable consisting of N13 and N14 reverts to logic '0' at its output: TED travels backwards!

Where do the two 'ones' come from?

The outputs of N5 and N6 are at logic '1' because the interconnected inputs (pins 9 and 5) receive a logic '1' from the monostable. N11 and N12 allow these logic 'ones' to pass, because their interconnected inputs receive a logic '1' from the second monostable.

If monostable 1 toggles back to zero, the state of the flip-flop must be transferred to the motors: it determines whether a turn to the left or right is made. If the output of the first monostable goes to zero, N5 and N6 deliver the flip-flop information via N11, N12, N7 and N8 to the motors. N11 and N12 are only inhibited when the second ('longer') monostable reverts to zero somewhat later. N9 and N10 are enabled again, thus restoring the original state.

2

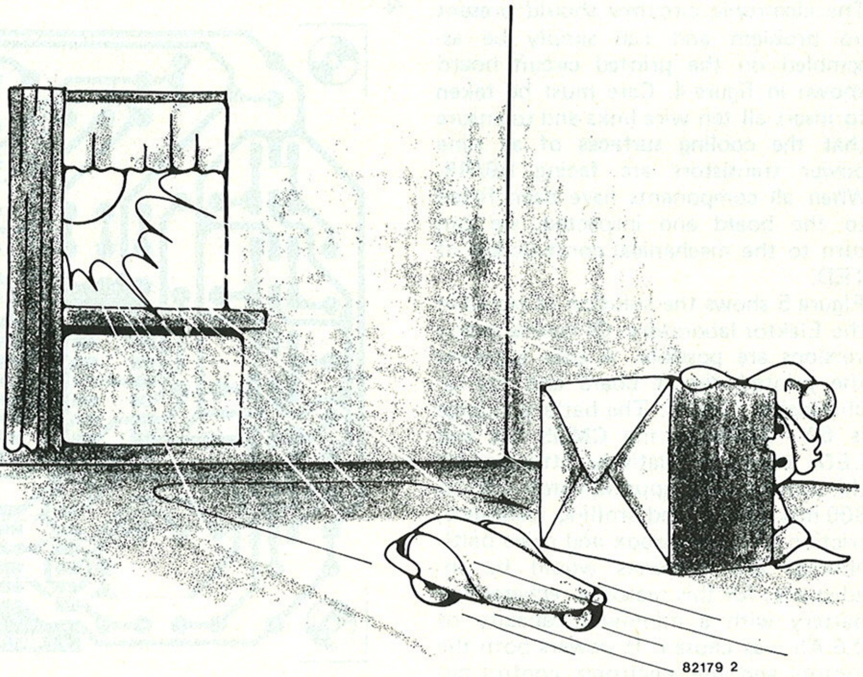


Figure 2. Since most windows do not extend down to the floor, the cybernetic creature often changes direction when travelling towards a window: when it penetrates the shade area, light objects are suddenly detected which were not noticed in the bright light of the window. When placed in its path, an object such as a cardboard box, waste-paper basket or even a human is avoided if — and this is important — it is between the light source and the creature and is therefore considered as background when viewed by the LDR 'eyes'.

3

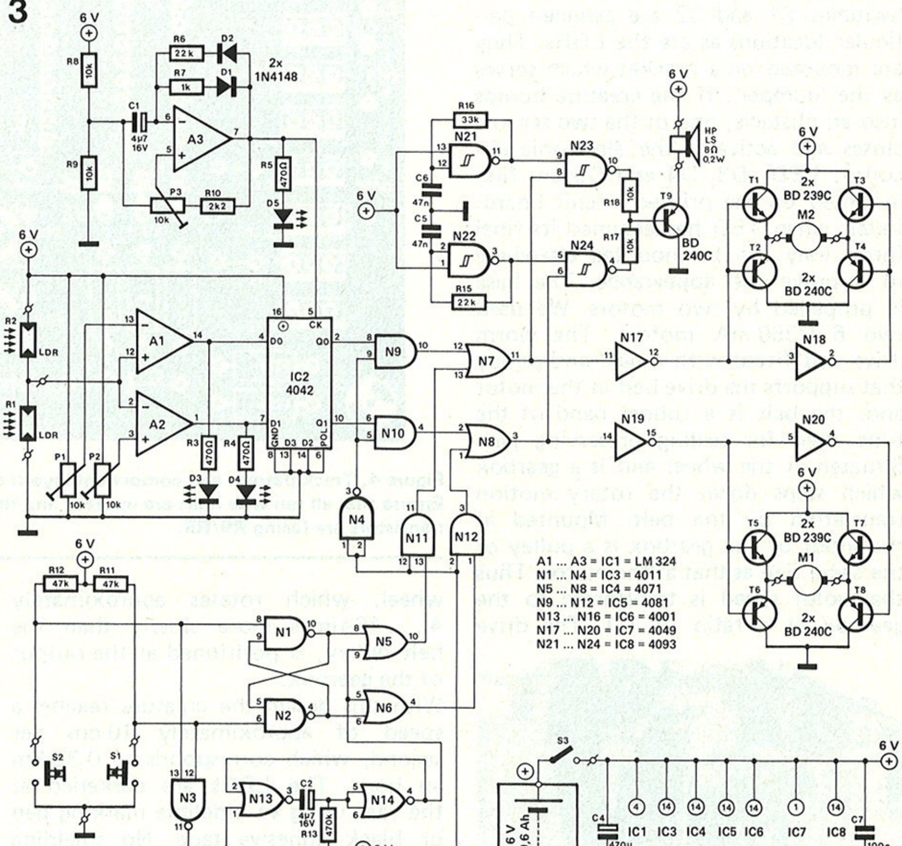


Figure 3. The circuit of the cybernetic creature, our TED evaluates the light impinging on R1 and R2; T1 . . . T8 provide the motor control circuitry; S1 and S2 evaluate 'contact with the enemy' and the sound generator with loudspeaker gives the creature its speech.

Construction

The electronic circuitry should present no problem and can simply be assembled on the printed circuit board shown in figure 4. Care must be taken to insert all ten wire links and to ensure that the cooling surfaces of all nine power transistors are facing R9/R8. When all components have been fitted to the board and inspected, we can turn to the mechanical construction of TED.

Figure 5 shows the solution as tested in the Elektor laboratory. Of course, many versions are possible. A base supports the printed circuit board and the rechargeable battery. The battery voltage is 6 V. Although the CMOS ICs and LEDs consume relatively little power, the motors draw approximately 250 to 300 mA under load (rolling resistance, friction of the gearbox and drive belt). Normal dry batteries would be inadequate; for this reason a rechargeable battery with a minimum capacity of 0.6 Ah was chosen. It powers both the motors and the electronic control circuitry. Any interference generated by the motors has no effect on the control circuitry. The two LDRs which form the 'eyes' are mounted externally on the left and right. The loudspeaker and battery switch S3 must also be connected and mounted somewhere on the base.

Switches S1 and S2 are assigned particular locations as are the LDRs. They are mounted on a bracket which serves as the 'bumper'. If the creature bumps into an obstacle, one of the two sensors closes and activates the electronic circuitry. LEDs D3, D4 and D5 are first mounted on the printed circuit board. Later, when TED has assumed its final form, they can be mounted elsewhere to improve the appearance. The base is propelled by two motors. We used two 6 V/350 mA motors. The worm drive was fitted with a gear and pulley that supports the drive belt at the motor end; the belt is a rubber band of the type used for sealing preserving jars. Situated at the wheel end is a gearbox which steps down the rotary motion transferred by the belt. Mounted at the input of the gearbox is a pulley of the same size as that at the motor. Thus the motor speed is transferred to the gearbox at a ratio of 1:1. The drive wheel, which rotates approximately 4 . . . 16-times more slowly than the belt pulley, is positioned at the output of the gearbox.

With this design the creature reaches a speed of approximately 10 cm per second, which corresponds to 0.36 km an hour. The LDRs are darkened at the rear using an indelible marking pen or black adhesive tape. No shielding against lateral light is required.

4

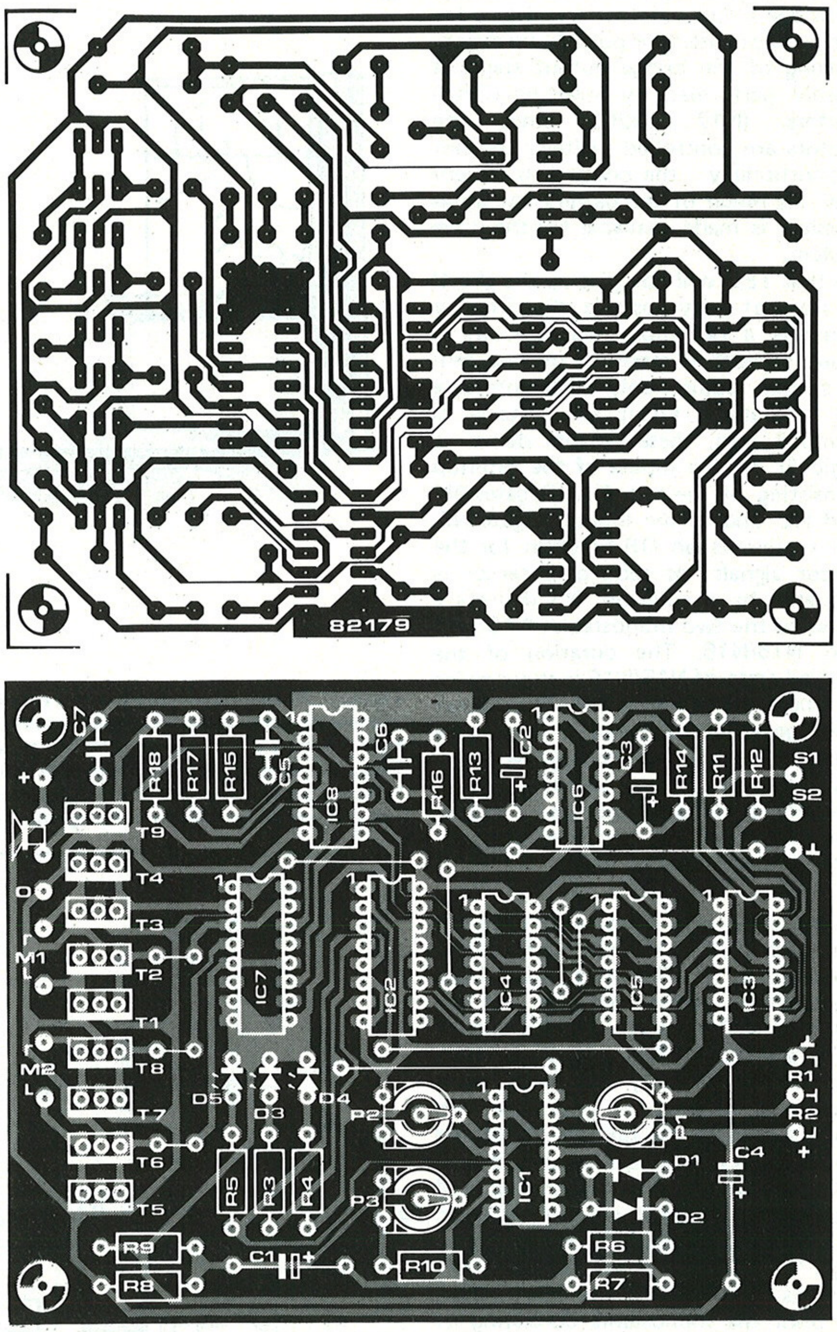
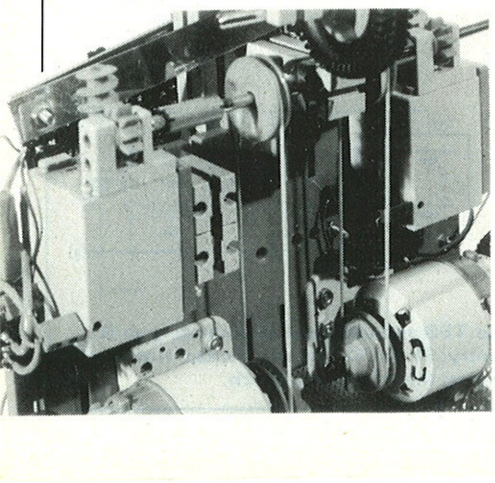


Figure 4. Track pattern and component layout of the printed circuit board for the Triopede. Ensure that all ten wire links are inserted and that the cooling surfaces of all nine power transistors are facing R9/R8.



Alignment

P1, P2:

These are used to establish the 'blind zone' in the visual range of TED. A change of direction of a light source within this blind zone must not cause any change in course. If the range of tolerance becomes too small or even zero, 'motor hunting' can occur, as already mentioned. If it is too great, obstacles can no longer be detected in time.

A room is chosen with a light source in the form of a single spot if possible (small window or light bulb). Place TED on the floor at a distance of a few metres from the light source and facing it with both 'eyes'. Then rotate it about 10 degrees to the left. More light now impinges on LDR1: the voltage at point A becomes greater than

5

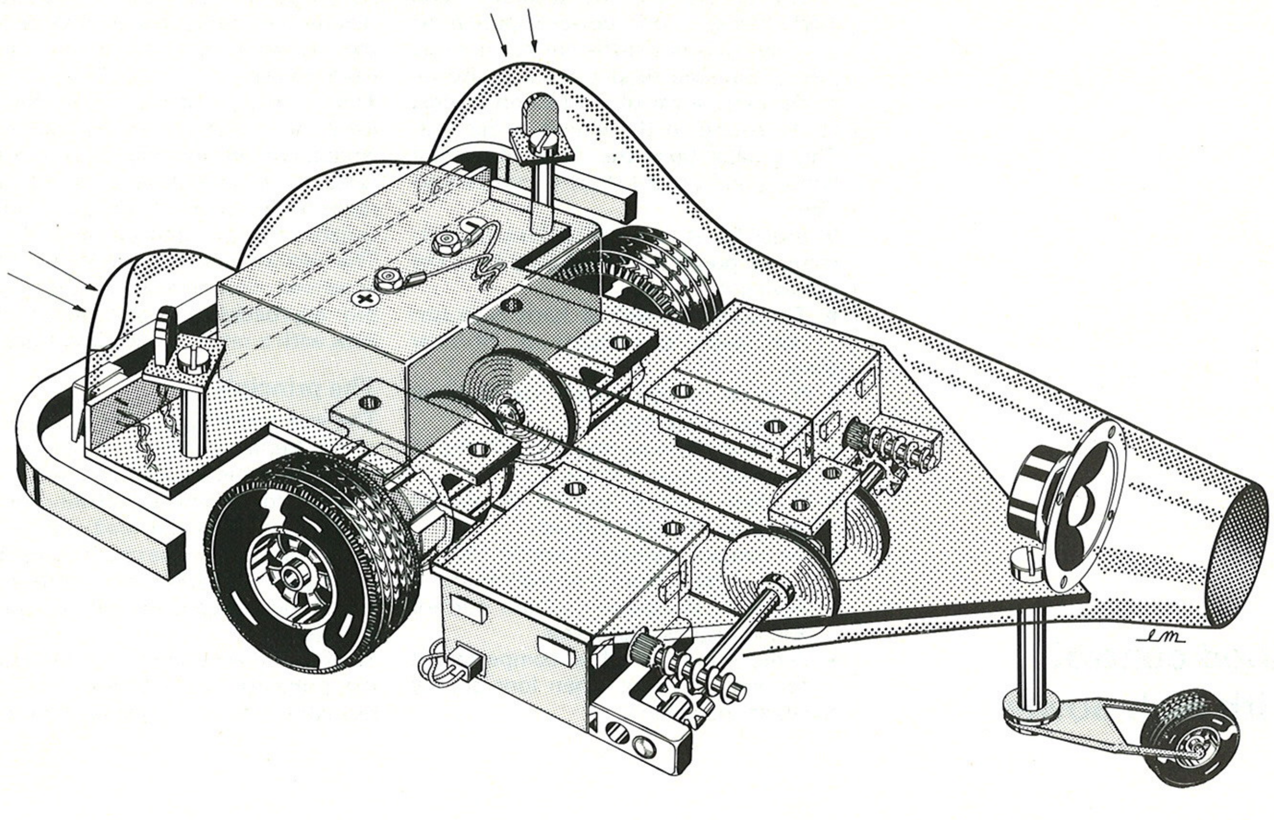


Figure 5. Here is the construction tested in the Elektor laboratory. A base supports the printed circuit board and the rechargeable battery. This base is propelled by two motors whose speed is reduced by gearboxes. The creature reaches a speed of 0.36 km/h.

Parts list

Resistors:
R1,R2 = LDR
R3,R4,R5 = 470 Ω
R6,R15 = 22 k
R7 = 1 k
R8,R9,R17,R18 = 10 k
R10 = 2k2
R11,R12 = 47 k
R13 = 470 k
R14 = 1 M
R 16 = 33 k
P1,P2,P3 = 10 k trimmer

Capacitors:
C1,C2,C3 = 4µ7/16 V
C4 = 470 µ/16 V
C5,C6 = 47 n
C7 = 100 n

Semiconductors:
D1,D2 = 1N4148
D3,D4,D5 = LED
T1,T3,T5,T7 = BD 239C
T2,T4,T6,T8,T9 = BD 240C
IC1 = LM324
IC2 = 4042
IC3 = 4011
IC4 = 4071
IC5 = 4081
IC6 = 4001
IC7 = 4049
IC8 = 4093

Miscellaneous:
LS = loudspeaker 8 Ω/0.2 W
S1,S2 = sensors (pushbuttons)
S3 = on/off switch
6 V rechargeable battery, 0.6 Ah min.

U/2. Adjust P1 so that LED 1 just begins to light up. Now rotate TED the same number of degrees to the right. Adjust P2 so that LED 2 just begins to light up.

During forward travel (with the light source dead ahead), neither of the two LEDs must light up. LED 1 and LED 2 must never light up simultaneously. This can, however, result from an incorrect adjustment of P1 and P2. Fine adjustment of the clock frequency can only be made while the creature is travelling. Its speed is very important. The clock frequency can only be adjusted to suit the mechanical construction of the propulsion system after a few trial runs. It is also interesting to observe the change in behaviour of the creature at different clock frequencies (approximately 2-10 Hz).

When it is switched on TED acts as though it had just bumped into an obstacle. Wait until the reverse travel and subsequent rotation have ended. For a functional check it is advisable to disconnect the link between the motors and the drive wheels.

Connecting the motors

The motors must be connected with the correct polarity so that TED will not unintentionally travel backwards or in a circle. The procedure is as follows:

1. Illuminate the LDRs in such a way that D3 and D4 do not light up. The two motors should now rotate for forward travel if they were properly connected.
2. Rotate TED so that the light source is at the front right (as viewed by TED). The right drive wheel should now rotate backwards and the left wheel forwards.
3. Rotate TED so that the light source is at the front left. The motors should now change their direction of rotation. The left wheel should run backwards and the right wheel forwards.
4. If, after bumping against an obstacle and reverse travel, the creature turns towards the obstacle instead of away from it, S1 and S2 should be interchanged.

Finally . . .

. . . all that is left is the final appearance of TED and this is a matter for individual appreciation. However, we would advise against a terrifying exterior; the 'cybernetic look' is probably quite sufficient. Have fun. ◀

precision power supply

Good control with high power

Any item of test equipment is useful but only one is absolutely necessary and that is some form of power supply. These normally provide a voltage output of up to 25 or 30 volts at about 1 amp which is fine for most purposes. However, this current level can be rather limiting when testing computers, audio amplifiers and other high power equipment. It is essential too that some form of protection such as current limiting is included in the circuit design. The precision power supply here is capable of providing up to 3 amps at 35 V and incorporates both current limiting and short circuit protection. Meters are included to enable current and voltage output levels to be monitored.

If any circuit is to be accurately and safely tested a good power supply must be used. It is not sufficient for it to be just a stabilised supply, it must also include some form of protection against faults arising in the circuit under test. This usually takes the form of current limiting and output short circuit protection.

In order for it to fulfil its function correctly, a power supply should have the following facilities.

- The ability to deliver fairly high current levels at voltages of 24 V or more.
- It must be completely stable at all output conditions.
- The output must have some form of short circuit protection.
- Current limiting control up to the maximum current output.
- An output voltage control that is fully variable from 0 to maximum.
- Accurate indication of both current and voltage output levels.
- Sense inputs to allow compensation for voltage drops when long supply cables are necessary.

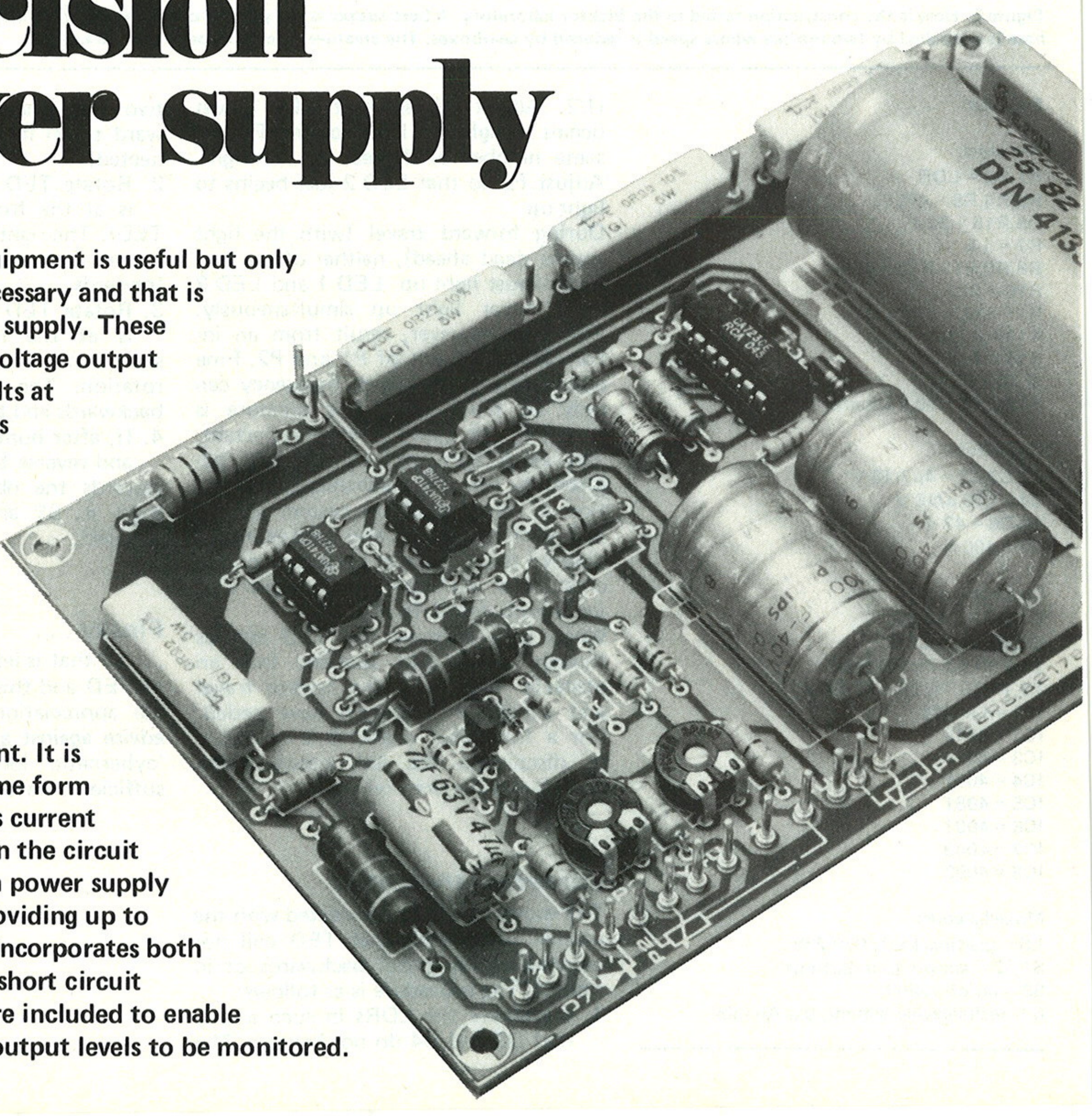
Although the last two points are not strictly necessary, their inclusion makes the power supply more versatile and easier to use.

The precision power supply here follows the standards set by commercial equipment and includes all of the above features. It has a variable output voltage range of 0 to 35 V and continuously variable current limiting up to 3 amps. The performance is on a par with fairly expensive commercial power supplies but approaches the stabilisation problems with a rather novel circuit design.

The principles

The vast majority of power supplies use either 'series' or 'pass' regulation. This means that the stabilising power transistors are connected (effectively) in series or in parallel to the load. In common with most designs the circuit here utilises series pass regulation. The originality in the circuit design is the method used for stabilisation.

The block diagram in figure 1a illustrates the principle of a conventional series regulator. The active element of the cir-



cuit is opamp A and its output is the source of the load current, that is, in series with the load R_L. The non-inverting input of the opamp is held at a reference voltage, U_{ref}. The inverting input of the opamp is at a voltage level that is a proportion of the input voltage — derived by potentiometer P. Under these conditions the output of the opamp will become stable at the point where the voltage difference between the two inputs is zero. That is, the opamp will maintain a condition where the reference voltage and that at the wiper of potentiometer P are equal. It will be obvious that the output voltage will therefore be dependant on the position of P. With the potentiometer in mid position the output will be double the reference voltage. The disadvantages of this system are that the stability factor is dependant on the setting of potentiometer P, the output can never be lower than the reference voltage and the operation of P will not be linear. Two of these points may not be so significant in some cases but an output minimum that is restricted to the reference voltage will be embarrassing to say the least!

The block diagram of figure 1b provides another solution. In this case, the opamp is used as a unity gain amplifier and P becomes a voltage divider connected across the reference voltage. The output of the opamp will now be proportional to the voltage level at the wiper of P. In this configuration the output range will be between 0 and the reference voltage. This sounds better but it is still far from ideal. The opamp will now require a negative voltage supply rail, an added disadvantage. The reference voltage must be at least as high as the maximum required output, not an ideal situation! Finally, the stability factor is still a question of potentiometer P.

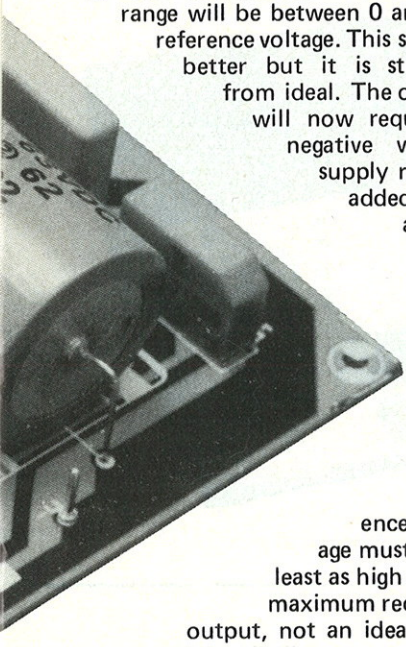


Figure 1c goes a long way towards removing the problems by replacing the reference voltage, as far as the opamp is concerned, with a reference current. The output voltage is now determined by the current passing through P. The advantage is that the circuit is no longer dependant on the reference voltage level.

We now arrive at figure 1d which, in principle, is very similar to 1c. The reference current in this case is derived from the output voltage via a series resistor R. The idea is not entirely new but the method used here is a little unorthodox.

As previously mentioned, a current source is achieved by placing a resistor in series with a reference voltage derived from the output. However, for this to happen in practice, the value of potentiometer P has to be much lower than R. The opamp still tries to balance out the difference between the voltage levels at its inputs but now the output voltage will be equal to the level on its non-inverting input.

The series resistor is effectively placed between the two inputs of the opamp. However, due to the high impedance of the inputs, theoretically at least, no current can enter the opamp. In effect then, the current derived from the reference source follows the path shown as a dotted line in the block diagram. Since $U_1 = U_2$ (the opamp ensures this) the current level remains constant, totally independant of P and the load. The current level is equal to $\frac{U_{ref}}{R}$. The opamp will balance out the voltage across P and, in doing so, the reference current is compensated for any change in load. The result of all this is that the circuit conforms to what we are looking for, a constant reference current (even at 0 V) using a reference voltage source and a resistor.

The precision power supply

The major difference between the block diagram of the precision power supply in figure 2 and that of figure 1d is the fact that two opamps and a series pass power transistor are included. The current source (U_{ref} and R) and the potentiometer P1 are very similar.

The second opamp A2 is responsible for output current limitating. The voltage across the emitter resistor R_s of transistor T is proportional to the output load current. A proportion of the reference voltage is derived by the setting of P2 and this is compared to the voltage across R_s by opamp A2. When the voltage across R_s becomes higher than that set by P2, the opamp reduces the base drive current to T until the difference is reduced to zero. The LED at the output of A2 functions as a current limiter.

The circuit diagram

So much for the theory, now for its practical application. The circuit of the power supply, shown in figure 3, has two independant power supplies (if that makes sense!). The power for the output stage is provided by transformer Tr2 which, of necessity, will be rather a hefty beast. Transformer Tr1 provides power for the reference source and the opamps.

The reference source is derived with the aid of the inevitable 723 (the worlds longest living chip?). The components

1

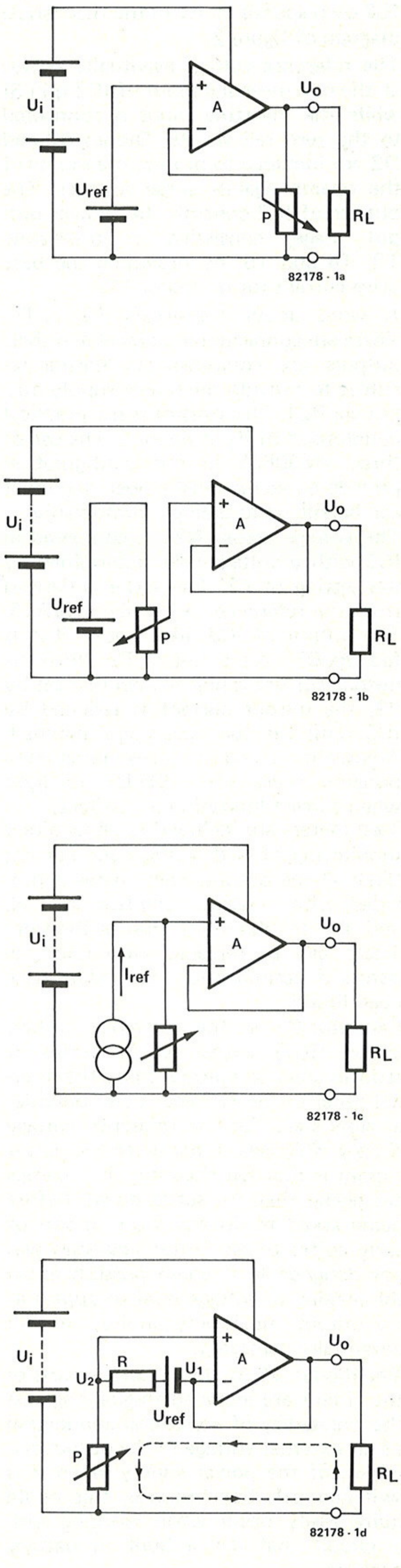


Figure 1. The drawings here, in conjunction with the text, illustrate the advantages of why the use of a constant current reference source is preferable to a reference voltage.

around this IC were chosen to provide a reference voltage of 7.15 V. This appears at the junction of R1/R5, R15/R16 and R9. For ease of understanding it should be noted that R4/R5 represents R and IC2 corresponds to A1 in the theoretical diagram of figure 2.

The reference voltage eventually arrives at the non-inverting input of IC2 (pin 3) while the inverting input is connected to the zero rail via R8. Diodes D2 and D3 are included to protect the inputs of the opamp against surge voltages. The output of IC2 controls the power output stage, consisting of transistors T3, T4 and T5, by providing the base drive current for transistor T2.

A word about transistors T3 . . . T5. These are connected in parallel and their outputs are combined via emitter resistors to provide the power supply output via R21. This resistor is the practical counterpart of R_S in figure 2. The use of three 2N 3055's in this configuration provide an economical power stage that can handle up to 3 amps comfortably.

The voltage across R21 is compared in IC3 with a voltage level determined by the setting of P2. This latter is derived from the reference source via R15/R16. The output of IC3, like that of IC2, is fed (via D5) to the base of T2. When the output current is higher than that set by P2, the output current is reduced by IC3 until the two levels are matched. Transistor T1 and its surrounding components cause the LED D7 to light when current limitation is in effect.

Two meters are included to allow direct monitoring of both voltage and current levels at the output. Each meter is provided with a series potentiometer, P3 and P4, to allow for fine calibration. These can be replaced with fixed resistors if desired once their values have been found.

Capacitor C3 in the reference voltage circuit (IC1) serves two functions. It reduces any noise produced by the internal zener of the 723 and it also provides a 'slow start' for the reference voltage supply. This means that when the power supply is first switched on, the opamps are giving time to 'settle down' before being asked to do any work, a sort of early coffee break! If this slow start was not designed in it could possibly allow the maximum voltage level to appear at the output, albeit very briefly, but still potentially damaging.

The diodes D1 to D8 in various parts of the circuit are included to guard against the possibility of accidental connection of an external voltage to the output terminals of the power supply when it is switched off. For instance, this could quite easily occur when working with a circuit that has a built in battery back-up.

Components R7 and C6 increase the reaction time of the circuit when changing output voltage levels while capacitors C7 and C8 eliminate the possibility of oscillation in the opamps. For stable operation of the circuit a minimum

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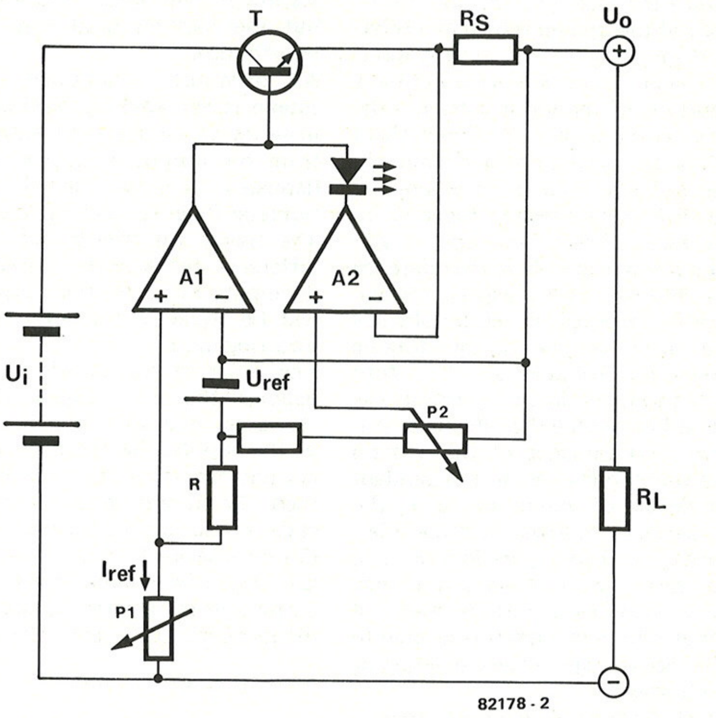
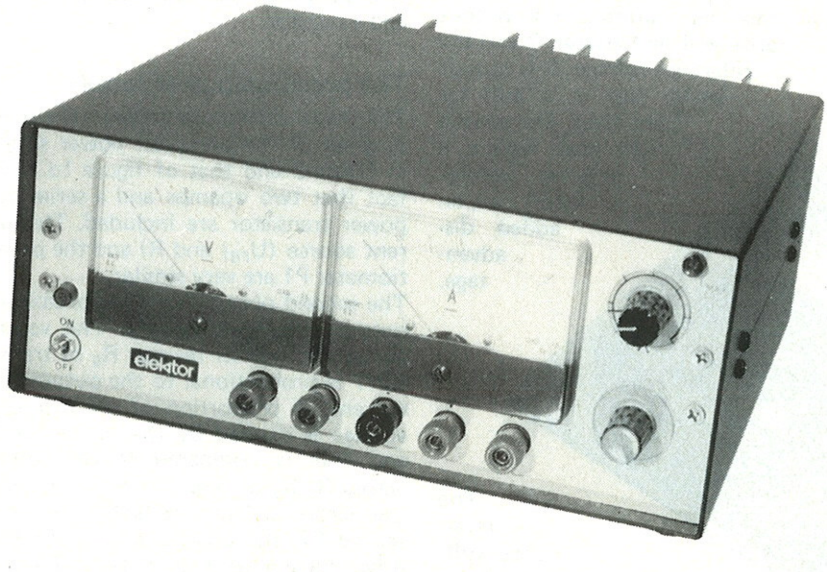


Figure 2. The basic block diagram of the precision power supply. Opamp A1 provides the voltage regulation while A2 takes care of the current limiting.



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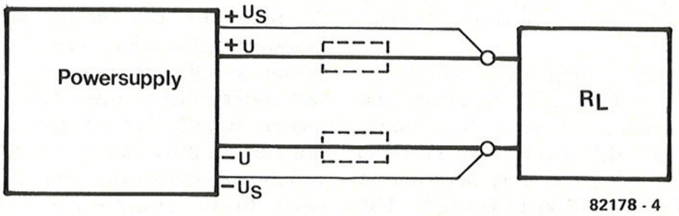

Figure 4. The two sense inputs are used in the manner illustrated here to enable the circuit to compensate for voltage drops caused by the use of long cables.

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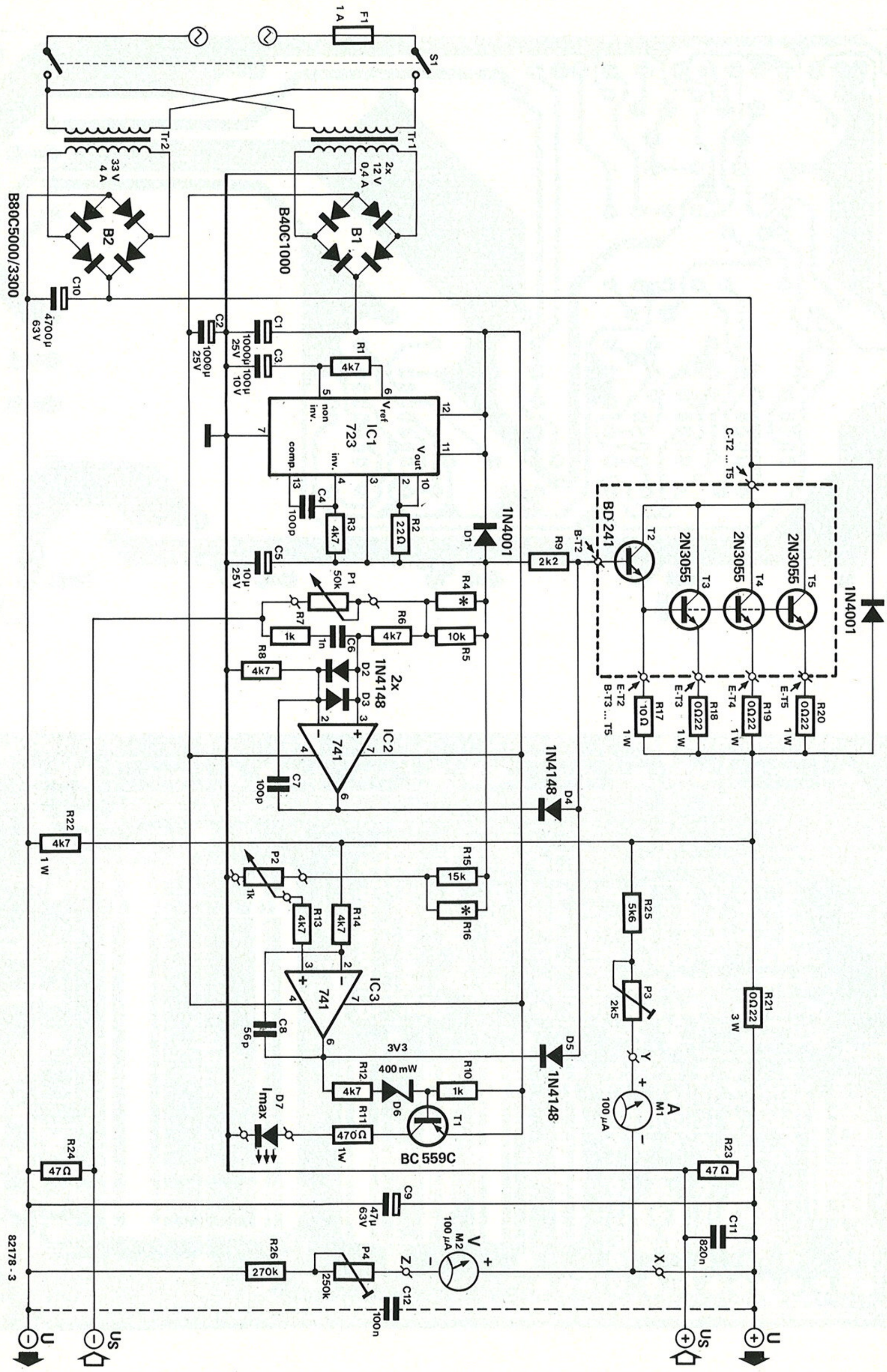

Figure 3. The circuit diagram of the precision power supply. Resistors R4/R5 correspond to R in figure 2, IC2 to A1, IC3 to A2 and R21 to R_S. Of the two transformers, Tr1 provides the supply for the reference current source while Tr2 supplies the power for the output stage.

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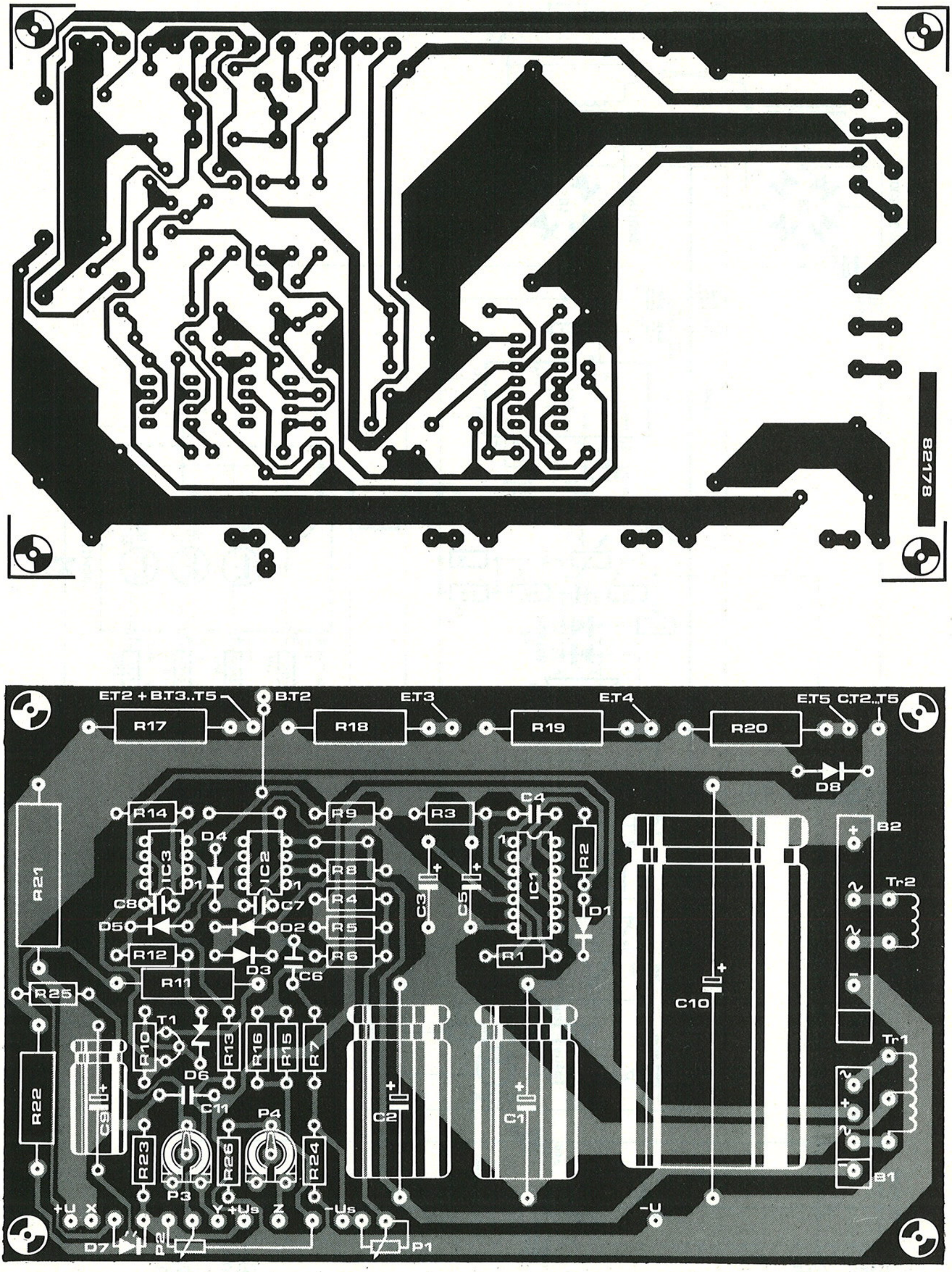

Figure 5. The track pattern and component layout for the printed circuit board used for the precision power supply.

Parts list

Resistors:
R1,R3,R6,R8,R12,R13,R14 = 4k7
R2 = 22 Ω
R4,R16 = see text
R5 = 10 k
R7,R10 = 1 k
R9 = 2k2
R11 = 470 Ω/1 W
R15 = 15 k
R17 = 10 Ω/1 W
R18,R19,R20 = 0,22 Ω/3 W
R22 = 4k7/1 W
R23,R24 = 47 Ω
R25 = 5k6
R26 = 270 k
P1 = 50 k potentiometer
P2 = 1 k potentiometer
P3 = 2k5 preset
P4 = 250 k preset

Capacitors:
C1,C2 = 100 μ/25 V
C3 = 100 μ/10 V
C4 = 100 p
C5 = 10 μ/25 V
C6 = 1 n
C7 = 100 p
C8 = 56 p
C9 = 47 μ/63 V
C10 = 4700 μ/63 V
C11 = 820 n
C12 = 100 n

Semiconductors:
B1 = bridge rectifier B40C1000
B2 = bridge rectifier B80C5000/3300
D1,D8 = 1N4001
D2 . . . D5 = 1N4148
D6 = 3V3 400 mW zener
D7 = LED red
T1 = BC 559C
T2 = BD 241
T3,T4,T5 = 2N3055
IC1 = 723
IC2,IC3 = 741

Miscellaneous:
S1 = double pole mains switch
M1,M2 = 100 μA meter
Tr1 = 2 x 12 V/400 mA mains transformer
Tr2 = 33 V/4 A mains transformer
F = 1 A fuse

output load resistance is necessary. This is taken care of by R22.

It will be noted that there appear to be more output terminals than the usual power supply needs. The two extra outputs, $+U_S$ and $-U_S$, are in fact inputs. These so-called 'sense' inputs are used to allow for voltage drop compensation when working with long connecting cables between the power supply and its load. Figure 4 illustrates how the inputs are used. Two extra wires are connected as shown between the load and the sense inputs. The result of this is that the supply voltage level is now effectively measured at the load and not at the output terminals of the power supply. This enables the circuit to compensate for any voltage drop resulting from the resistance in the main supply cables. It should be noted that if the total resistance of the two main supply cables is 1 Ω, at the current level of 1 A the voltage drop will be 1 V. In normal use,

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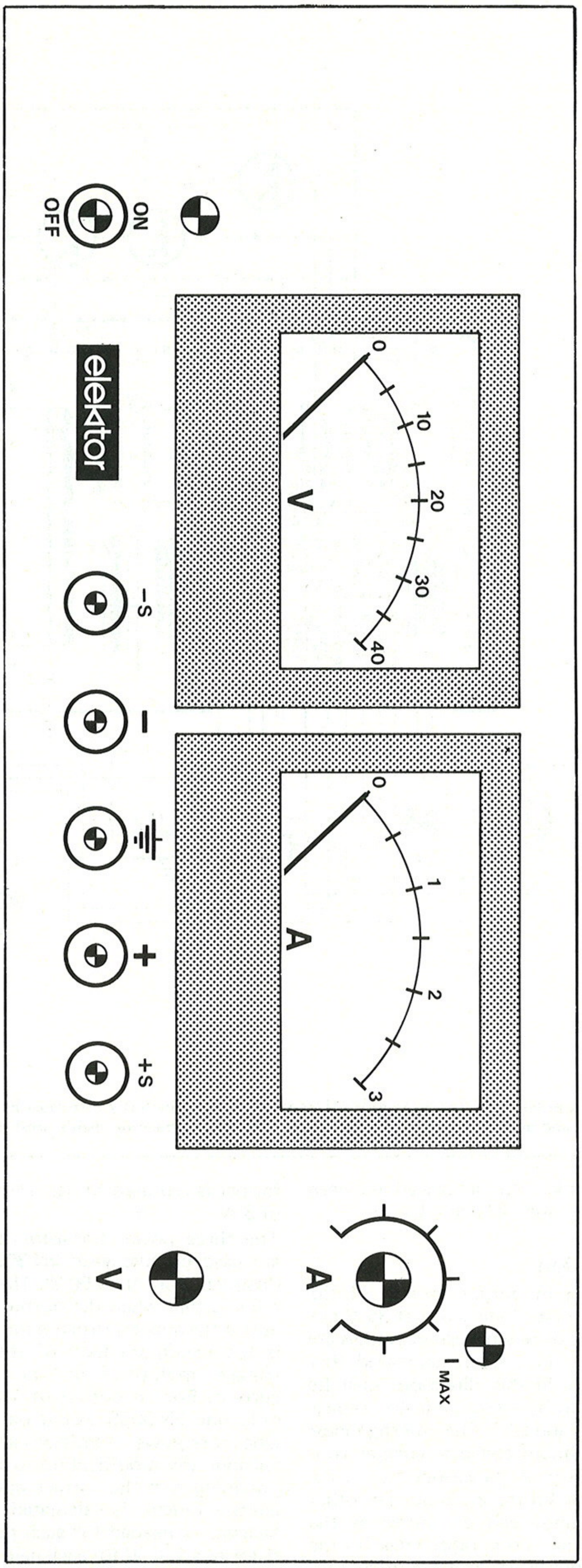

Figure 7. The design of the front panel that is available from Elektor. It is manufactured from scratch resistant polycarbonate material and is self-adhesive. The illustration is at a reduced scale, the actual size is 11 cm by 30 cm.

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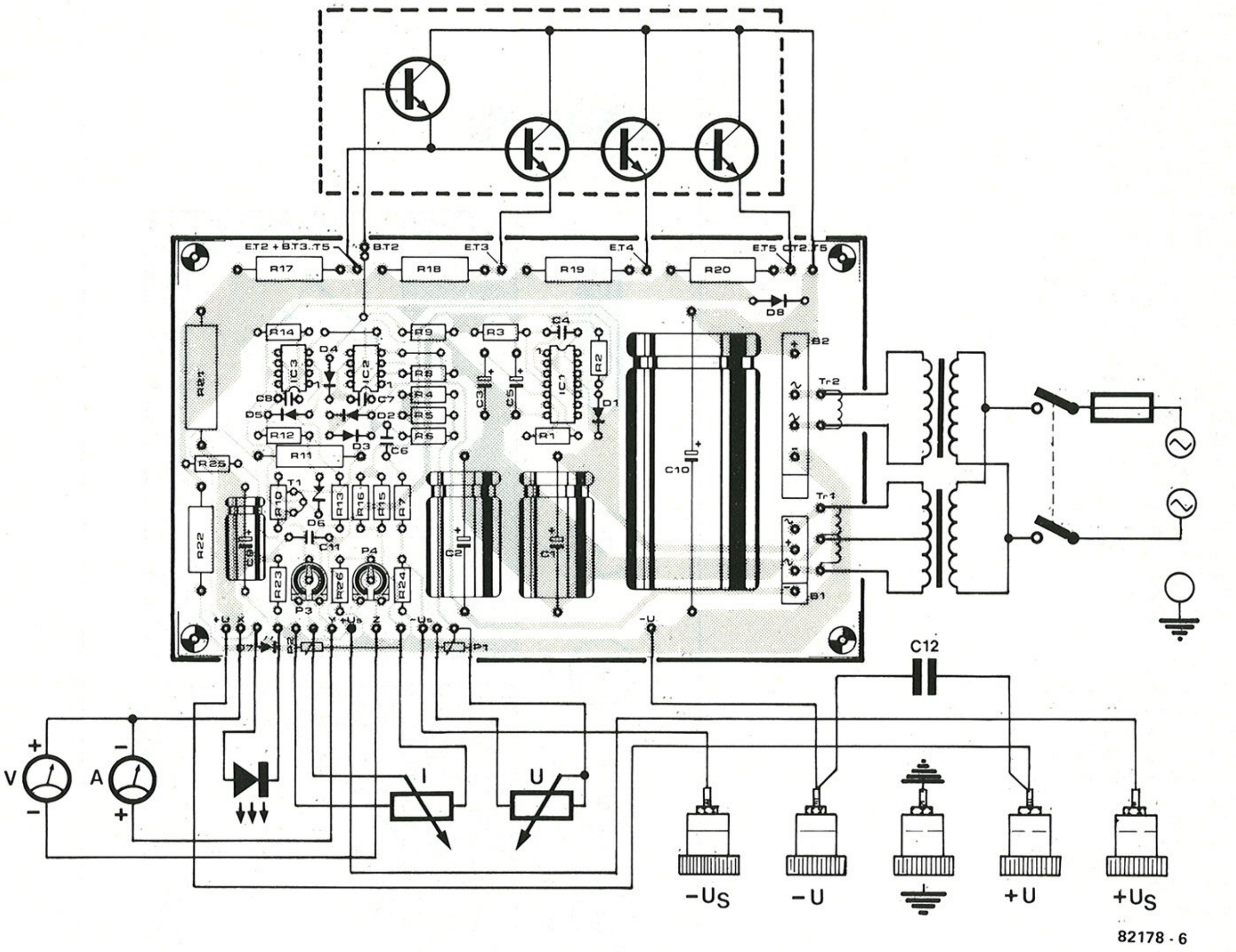


Figure 6. The practical wiring diagram for the power supply. Obviously care must be taken with connections, especially with respect to the transformers and power transistors. Errors in this area will not become visible until the smoke clears!

shorting links can be placed between +U and +U_S, and —U and —U_S.

Construction

The maximum output current of the circuits as shown here is 3 A at 35 V but in principle different current ratings are possible. It must be remembered that any change in this direction must be accompanied by a change in the ratings of both C9 and C10. The limiting factor is the maximum collector/emitter voltage capability of transistors T2 . . . T5. This is 60 V for the 2N 3055. The other deciding factor will of course be the current rating of the transformer for the power output stage. The maximum output of the power supply is a factor $\frac{1}{\sqrt{2}}$ of the current supplied by the transformer which explains why a 4 A transformer is required to achieve an output of 3 A.

The three power transistors in parallel are used because each 2N 3055 cannot dissipate more than 50 W. The consideration is that when the output voltage is at 0 V the maximum dissipation required is the maximum level of the rectified voltage multiplied by the maximum current. For an output of 1 A at 35 V only one 2N 3055 would be sufficient. One more power transistor can be added without any modification to the circuit providing that the correct value for the emitter resistor is calculated. A 2°C/W heatsink is needed for each power transistor or a 1°C/W for each pair. Capacitor C12 is mounted directly onto the output terminals as shown in figure 6.

Do not mount the resistors R4 and R16 initially as their value will depend on the maximum output voltage and current. For this reason it will not be possible to mount the printed circuit board into the case until test and calibration is completed. Set P1 to maximum, switch on and connect a multimeter to the output of the circuit. By trial and error find the actual value of R4 which gives the maximum required output voltage. This can be done by connecting different resistors in parallel to R5. When the correct value has been found it can be soldered in place on the board. Repeat the exercise with P2 and R16 (in parallel with R15) until the maximum current level is found.

The remaining calibration is that of the meters by adjustment of P3 and P4. It is possible to build the power supply using only one meter. In this case a 2 pole 2 way switch connected to points x, y and z is required to switch between volts and amps. ◼

the Elektor XL range

an audio system that sounds good – and looks good!

Over the years, Elektor has built up a reputation for producing reliable and well-designed circuits for home construction. In the audio field, we have produced preamps that vary from the cheap-and-n . . . not-too-bad to the top quality all-singing-all-dancing variety; power amps from the milliwatt range up to 'quality-power'; noise reduction systems, indicators, distortion measuring gear, a stylus pressure gauge even. Now we've got some more in the pipe-line: the XL range.

In this case, we feel that a general introduction is called for. What is the XL range? What is special about it? In a nutshell, it comprises a series of very high performance audio components that can be built at sensible prices. The quality should come as a pleasant surprise, even to the serious audiophile, and the final appearance needn't be a disgrace to the living room. In other words, it is not intended to be competitive in the low-budget category; not it is expressly intended to be a competitor in the £1000+ range. High quality, plenty of features if you want them, reliability and a reasonable price: these were the main design goals. Our new front panels add the finishing touch.

How it all started

Way back in '78, one of our many hi-fi enthusiasts drafted an eight-page memo on what we ought to do in this field. It suffered the fate of most memos: interested study, brief discussion, filing cabinet . . . However, the idea kept on nagging in the back of our minds. And when an idea is irritating the grey matter in some two dozen fertile, technically oriented brains, something must happen eventually. Then, early this year, your editor was wondering what large project would be worth tackling in the winter months, as a series of articles. From past experience, a truly consecutive series seemed unwise: no matter how carefully it is planned, the designers always get second thoughts halfway through – and want to redesign some forthcoming part. It then becomes a battle royal to keep the articles appearing at monthly intervals. (For those readers who have wondered why nearly all magazines tend to leave gaps in a series 'for reasons of space': now you know the true reason!)

The two things came together. A series of articles describing a complete audio system! You can publish the various components in any order – and if you miss a month, nobody's any the wiser. Now (second thoughts again!) we decided to play it straight: we'll tell you what we intend to publish, but we don't make any promises as to when! You can take your pick from one of the stock phrases: in the near future, soon, over the next few months, starting now . . .

Over the past six months, we've been having a lot of fun: no-wild-ideas-barred brainstorming! What features would you like? What features seem even vaguely feasible? To give you some idea of the things we've been thinking of, we can run through the various items in the system. No promises, mind! These are 'brainstorm' ideas, and not all of them are economically and/or technically feasible.

Power amplifier: Crescendo

100 W? 250 W? Bandwidth from DC to passing-bat frequencies, or restricted to suit the human ear? Transistors, opamps or MOSFETs? End of discussion: the final circuit is described elsewhere in this issue. As specified in that article, it uses MOSFETs to deliver plenty of undistorted power – enough to coax pleasing sounds at a more than adequate level from even the most inefficient of 8 Ω speakers

During our think-tank sessions, we dreamed up some features. DC protection for the speakers seemed a 'must' – so we'll describe that next month (promisė!). A power-up countdown with visual indication is fun, and avoids nasty thumps – so it is included. Then there's a choice: where do you put the amplifiers? In the rack, on the floor, or in the speaker cabinets? The design caters for all options – but if you mount it in a rack, you need something to put on the front panel. The mains switch, of course; power output indicators, possibly? Hey . . . why not add a thermometer on the heatsinks! When the system is switched off, it will double as room temperature indicator.

Preamp: Prelude

What should a preamp do? It boosts the input signal, selects the one you want, provides tone, volume and balance controls, feeds signals to a tape deck and headphones, and may do a lot more things as well: noise reduction, remote control, level indication . . . Wow! A design that includes everything might be rather expensive, and one that does not include everything might disillusion some audiophile. So what do you do? Make it 'modular'! That way, all the various bits and pieces can be added or omitted according to personal taste. The design that we're finalising at present includes:

- both dynamic and moving-coil preamps that can be tailored to suit virtually and high-quality cartridge
- tone controls that include all mod cons
- for the true audiophile: tone control cancel option
- separate headphone amplifier
- input sensitiviry adjustment
- dual input channel switching: one for listening and the other for recording on tape
- remote control option, as outlined below

Remote control: Baton

Your editor would have liked a system that included motor-drive of the control potentiometers. No quality loss, and just think of the 'effect': hit a button on the remote control unit, and the corresponding knob on the panel starts to rotate! However, this would involve a difficult and expensive mechanical system, so we settled on an electronic (infra-red) version. For top-qualityphiles: the unit can be omitted or, if it is included, cancelled.

Loudspeakers:

When did we last publish a loudspeaker design? Way back! Why haven't we published one since? Because loudspeaker design is a specialised art – it's much easier to design a bad one than to create something really good! – and because manufacturers have a provided several good designs for the home constructor.

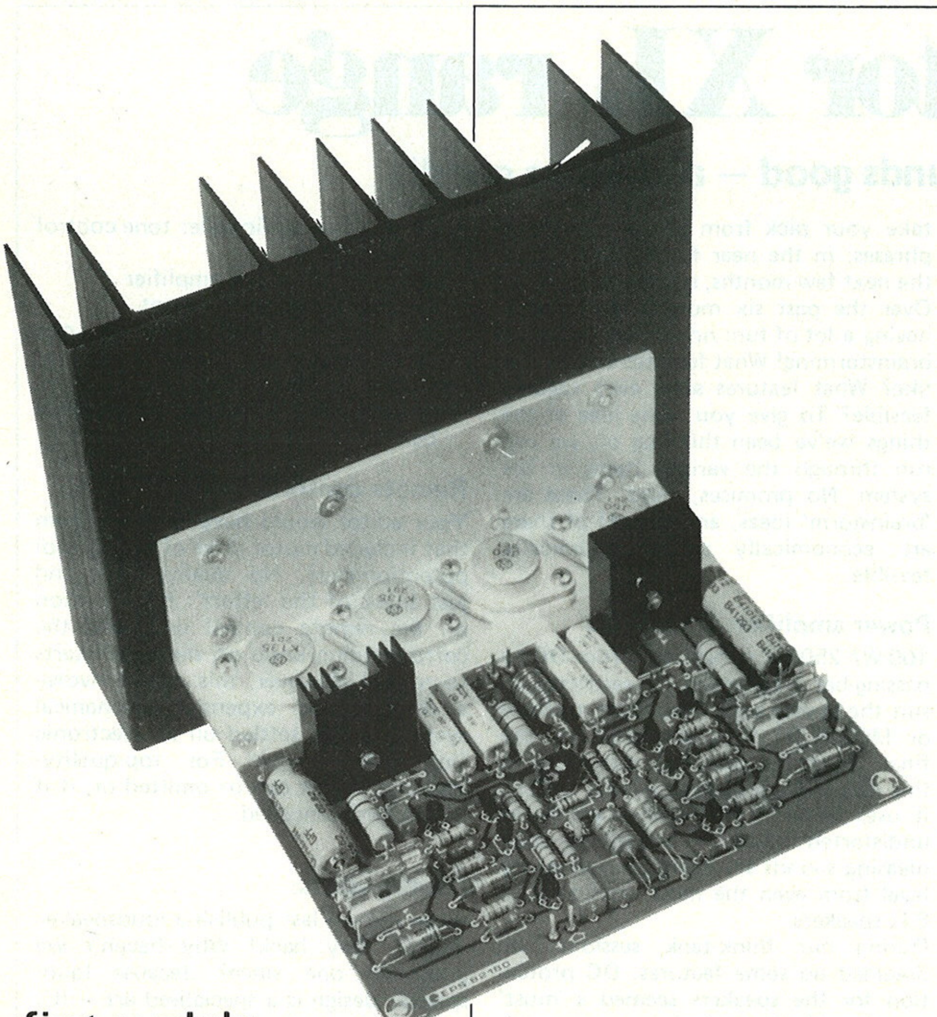
Even so, we felt that the XL range ought to include one or more designs for this all-important component. At present, we have several interesting and promising possibilities in the pipe-line. But we haven't seen or heard any of them yet, so we are very reluctant to make any firm promises. Suffice it to say: if and when we publish a design, rest assured that it comes from a reputable specialist in this field!

FM tuner

We haven't even thought of a 'musical' name yet! What we have in mind should be revolutionary; in fact, 'in-house' it has been dubbed the FM-2000. High performance, easy to operate, microprocessor-controlled . . . Wait and see!

XL

Why did we call this the Elektor XL range? What does XL mean? An honest answer: we don't know, but it sounds nice! We picked those letters six months ago, because they have a nice high-quality 'sound', and we've been racking our brains ever since for a good explanation. 'Excellent'? 'Extra Luxury'? 'Exclusive'? Forget it! It's simply a series of audio gear that we'll be describing from now until . . . then.



first module in the audio XL range

crescendo

Power MOSFETs are available as P-channel and N-channel types. This makes it possible to design a class B amplifier in which both types operate with 'time sharing' — to borrow a term from the computer field. Since there are limits to the power rating of such a MOSFET, we have used what could be described as double 'job sharing' in this design: an output stage with two N-channel and two P-channel MOSFETs. The result is an output stage capable of great output power and exhibiting extremely low distortion.

The principle

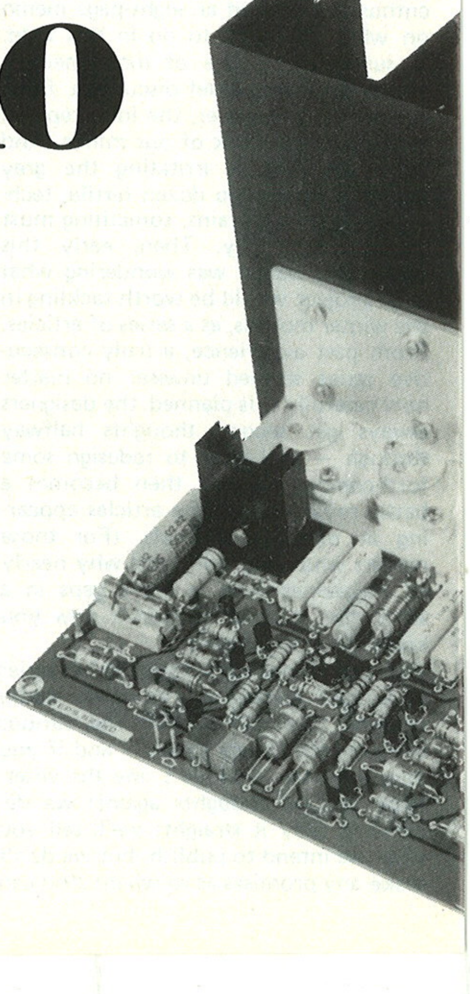
If one takes a passport photograph and folds it downwards in the middle, over the nose and between the eyes, the two halves will certainly not be identical. The same applies to many amplifier designs. In our case, of course, we are less interested in the visual distortion than in the harmonic and non-harmonic distortion as a result of non-symmetrical amplifier design. These types of distortion can be avoided by proper, symmetrical design of the circuit.

The reason is as follows: the distortion of even harmonics produced on each side of the symmetry line finally cancel each other out (as AC voltage into the load impedance). The result is less 'cosmetic circuitry' in the form of feedback or other alternatives, in order to meet the high requirements for quality of the output signal. Since the medicine (feedback) is usually worse than the malady (lack of stability, dynamic distortion (TIM), it is a good idea to try to avoid the ailment and reduce the dose of medicine.

Let us return to the analogy of the passport photograph. Looking at the block diagram of figure 1 or the circuit diagram of figure 2, if we draw an imaginary line along the middle we can see that each component has its counterpart. Components which are only present once are assigned to the common input or output (including feedback). There is one exception: we only need one trimmer potentiometer (P1) to set the quiescent current.

The input circuitry in figure 1 begins with a highpass filter consisting of R1, C1 and C2. This filter is necessary for two reasons: firstly, to prevent very low frequencies from reaching the bass loadspeaker, and secondly to block any DC that may be present at the input. Any DC component would appear at the output and unbalance the quiescent current setting of the output stage. The lowpass filter consisting of R2 and C3 was designed to pass signals with frequencies of up to approximately 160 kHz.

The double differential amplifier consisting of T1 . . . T4 is represented with two operational amplifiers in figure 1. The output signals of the two differential amplifiers (voltage over R11 and R13) result from the comparison between the input signals and the output signal attenuated by R4, R5 and R6. In other words, the feedback



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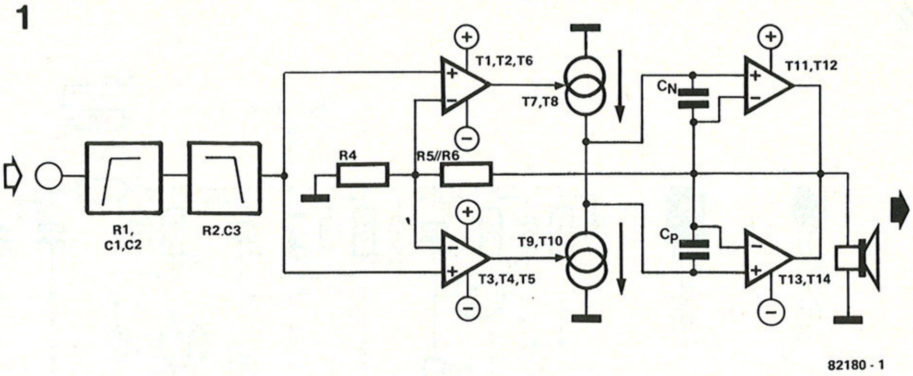


Figure 1. 'A line along the centre': the block diagram of the power amplifier shows the symmetrical arrangement.

effect is contained in the voltages over R11 and R13. For AC voltages the amplification is 1 + (R5/R6)/R4 = 32. For DC voltages the amplification is 1. This is catered for by C4 and C5. Without these two capacitors, the offset of the double differential amplifier would also be amplified by a factor of 32.

This offset consists of the different base-emitter voltages at the given collector currents and of any difference that may be present between the voltage drops over R1 + R2 and over R5/R6 (resulting from the base currents of T1/T3 and T2/T4 that may not be equal). However, this last contribution to the offset voltage can be ignored if R1 and R2 in series are equal in value to R5 and R6 in parallel. This explains the apparently unnecessary parallel connection of 39 K and 150 K instead of *one* 33 K resistor. Ideally, the current flowing from the base of T3/T4 will be as great as that flowing into the base of T1/T2. In this case the voltage drops are zero. Incidentally, this article also explains how the low output offset of +20 mV can be reduced even further.

The current source 'supply' (T5, T6) turns the input stages into good differential amplifiers and poor analogue adders: amplification and non-linearity (excluding the feedback effect) for common signals are low. The influence of slow and rapid variations in the operating voltages (100 Hz hum plus sinusoidal halfcycles at the signal frequency) on the desired signal is zero squared. One more comment on the differential amplifiers: R12 and R14 ensure that the collector-emitter voltages of T1 and of T2 and those of T3 and T4 are almost identical. In this way, thermal balance between the two differential amplifiers is achieved, resulting in a favourable effect on the offset.

The differential amplifiers supply the drive voltages (via R11 and R13) for two current sources: the sources of the drive current for the output stage consisting of T11 . . . T14. Each of these current sources consists of a cascade circuit of two transistors: T7 and T8 at the top and T9 and T10 at the bottom. This apparently unnecessary duplication of components provides many advantages. Each cascade forms a 'super transistor' with a current amplification factor of at least 400 and with a straight and almost flat I_C (U_{CE}) characteristic extending up to collector voltages of 250 V, and with an equally linear, frequency and voltage-independent collector-base capacitance of a few tenths of a picofarad, which can be made as small as the p.c.b. layout will permit. What we have is an ideal, text-book current source for frequencies from DC to 0.5 . . . 1 MHz. How is this achieved? There are two contributing factors. the first is 'job sharing'. This high current amplification is provided by T7 and T9, operating at low level (a few volts), whilst T8 and T10 handle the high voltage and dissipation. The current amplification of T8 and T10 can be ignored, because the currents flowing in their emitters are almost 100% equal to those flowing in their collectors. The second factor is screening. Two parallel, metallic surfaces present a capacitance. Now what if this capacitance is undesired? The simple solution is to take a third metal surface and place it between the other two. This third surface eliminates the original capacitance and creates two new, considerably lower and less harmful capacitances. In figure 2 the base of T7 and (T9) forms one electrode, the collector of T8 (T10) forms the other electrode and the base of T8 (T10) forms the intermediate electrode.

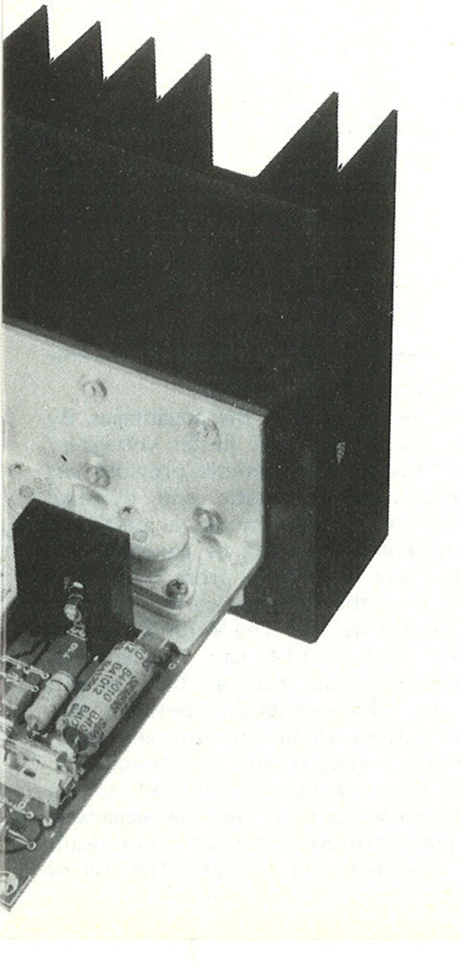
Why is this screening so important? The 'eliminated' collector-base capacitance in this amplifier is present anyway (a few picofarads) and it is non-linear. One can imagine it as a varicap diode with a capacitance which is greatly dependent on the inverse voltage. In many amplifier designs this non-linearity is cured by connecting a capacitance in parallel which is 50 to 100-times greater. This Miller capacitance, as it is known, also serves as a stabilizing capacitor. The solution is not optimum, however. It is better to avoid capacitance altogether, no matter how linear it may be!

The collector-base capacitances of T8 and T10, which are special video transistors, are very low. This capacitance (2 x approximately 2 pF) is effectively between collector and ground and cannot cause any mischief. However, this cascade solution has its price: the dynamic range of the output stage is restricted as a result of the necessary DC voltage setting. But this does not present a problem because it is better for the top end of the dynamic range to be restricted by the cascade circuit than by the saturation phenomenon in the output stage itself. This in turn has a favourable effect on recovery after an overload.

The DC voltage setting of the cascades and of the differential amplifiers is performed by zener diodes D1 and D2, which are connected to the operating voltage via R17 and R18. The result of this 'joint operation' of the zener diodes with C8 . . . C11, R19 and R20 is that the DC setting of T1 . . . T4 does not change in the slightest (in the event of operating voltage variations).

Let us now consider the output stage. It can handle a peak current of 14 A and a dissipation of 320 W at 50°C. Short-duration current limiting is performed by D3/D5 and D4/D6. In the event of long-term overcurrents, fuses F1 and F2 ensure the necessary shutdown.

The output stage is adjusted to a



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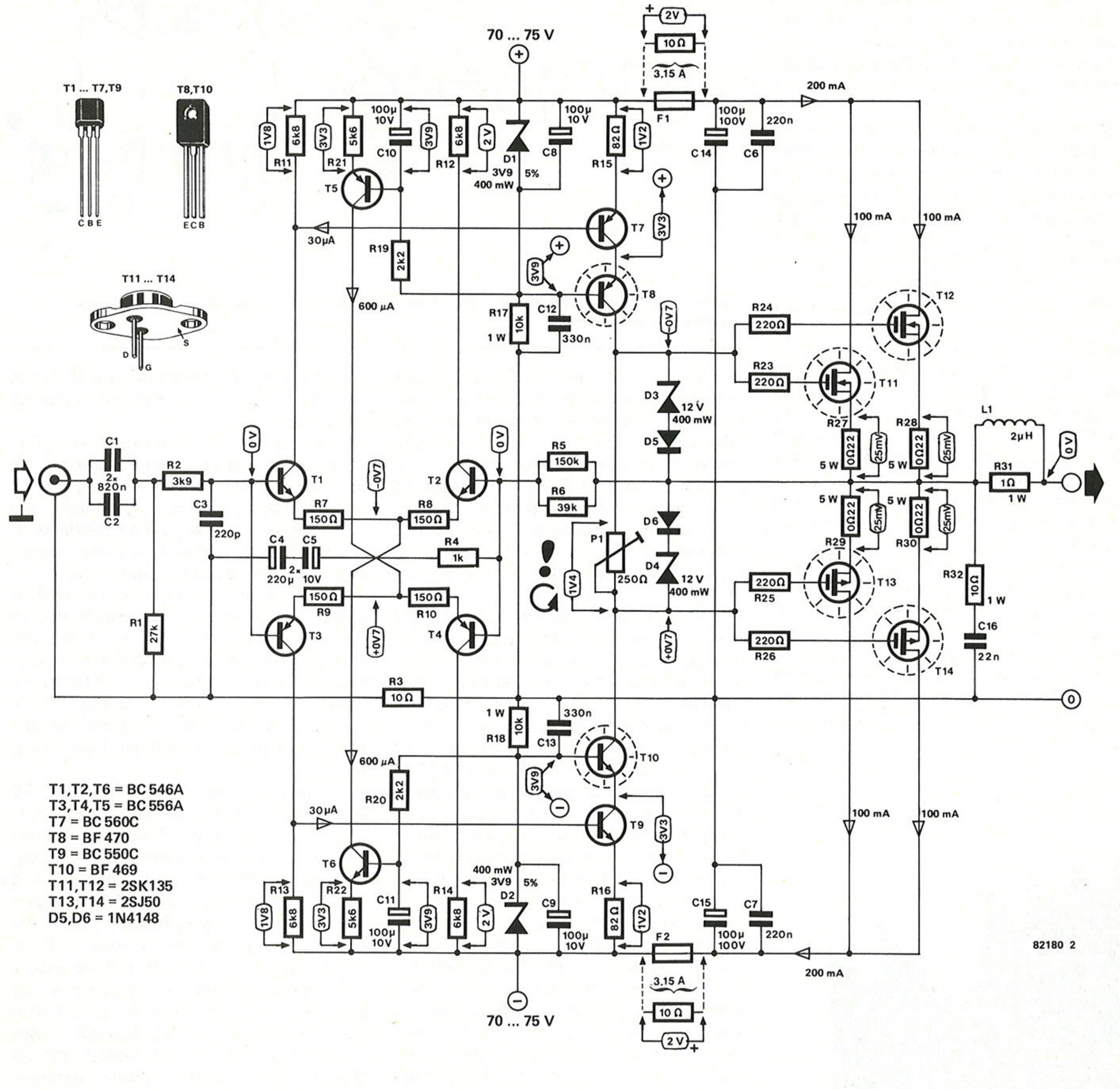

Figure 2. Circuit of the Crescendo power amplifier showing the test points.

quiescent current of 2-times 100 mA. This current is more than adequate to provide sufficient 'overlap' (simultaneous conducting) of the two output-stage halves to keep any distortion (that might arise from insufficient or even no quiescent current) at a very low level. With drain currents upwards of about 100 mA, this current decreases as the temperature rises at a constant gate-source voltage. This negative temperature performance of the MOSFETs ensures that the output stage cannot overheat. With conventional NPN/PNP output stages, certain measures must be taken to prevent this hazardous situation. No such measures are required with our design. It is merely necessary to set the quiescent current with P1. No additional diodes and transistors are needed.

The MOSFET output stage exhibits a considerably flatter output current/input voltage characteristic than that of a conventional output stage. This results in advantages and disadvantages. Let us first consider one significant disadvantage. The output stage is configured as a complementary source-follower. This means that maximum drive is determined by the operating voltage less the drive voltage. Since the drive voltage for MOSFETs must be higher than normal with the same AC output voltage, the result is a reduced dynamic range at the given operating voltages (a further restriction is created by the voltage drop over the relatively high saturation resistance of a MOSFET).

Now let us look at the advantages. By its very nature, the flatter voltage-in/current-out characteristic provides less opportunity for static and dynamic distortion. Furthermore, a particular quiescent current can be adjusted with P1. There is no jump from 0 to about 1 A when the quiescent-current trimmer is rotated by 10°. The MOSFET output stage T11 . . . T14 can handle high frequencies as well as high output power. The relationship between output current (drain current) and input voltage (between gate and source), i.e. the slope, remains unaffected by the frequency right up into the megahertz region. However, this can also result in a tendency to oscillate. The risk of

Table 1. Technical data

General:	• Fully symmetrical/complementary hi-fi MOSFET output stage • Good dynamic charcteristics because the internal 'inertia' of the *input* is utilized for full frequency compensation (designed for unconditional stability).
Output power	• 140 W into 8 Ω when both channels are simultaneously driven at a distortion factor which does not exceed 0.01% (−80 dB) within the frequency range 20 Hz . . . 20 kHz. Total power output: 280 W. • 180 W into 4 Ω when both channels are simultaneously driven at a distortion factor which does not exceed 0.01% (− 80 dB) within the frequency range 20 Hz . . . 20 kHz. Total power output: 360 W. • 180 W max. per channel into 8 Ω (fully driven) • 250 W max. per channel into 4 Ω (fully driven)
Input sensitivity	1 Vrms for 130 W into 8
Input impedance	25 kΩ
Frequency range	4 Hz . . . 160 kHz + 0/− 3 dB (with a source impedance of 600 Ω).
Attenuation factor	100
Output offset voltage	Less than ± 20 mV DC
Extras	• DC output protective circuit, combined with activation delay • Temperature sensor for heatsink • VU meters

oscillation is largely avoided by keeping the wiring as short as possible, decoupling capacitors (C6, C7, C14 and C15), limiting resistors (R23 . . . R26) and, with somewhat less influence, (R27 . . . R30.

The two capacitors C_N and C_P in the block diagram of figure 1 represent the input capacitances of the MOSFETs. Over the operating range of the amplifier, the voltage over C_N and C_P is independent of the frequency and relatively proportional to the output current. The frequency-dependence is based on the drive current delivered by the driver stages T7 . . . T10, which rises with the signal frequency and/or the output current. However, this drive current is none other than the charging/discharging current of C_N and C_P.

The result of having a current that rises with frequency is that the voltage over R15 (R16) also increases with frequency. The same applies to the voltage over R11 (R13). The advantage of this arrangement soon becomes clear. As in all amplifiers with feedback, the so-called open-loop gain (= gain *without* feedback) must drop with increasing frequency, as of a particular point. The drop must be such that the frequency rolloff at which the open-loop gain is one is not quite 12 dB per octave, i.e. just before the point of causing a 180° phase shift. This is not an invention of Elektor, but was established by two gentlemen called Bode and Nyquist some time ago.

This not-quite-12 dB, not-quite-180° situation characterizes the stability minimum. If one wishes to remain in the safe region of 6 dB per octave and 90° phase shift, in order to allow capacitive loads or capacitive contents of loads (crossover networks), the open-loop gain must roll off with 6 dB per octave from a 'safe' frequency onwards (which is now considerably higher). In all cases this must be up to the frequency at which the amplification has become one, but beyond that point if possible. The maximum open-loop phase shift in this case is 90° in the quiescent state; the system is unconditionally stable. It is almost always necessary to create these conditions by affecting the open-loop gain, i.e. by providing *compensation*. In most cases this is accomplished by inserting a compensation capacitor.

With our circuit, however, this is unnecessary. If the open-loop gain decreases with 6 dB per octave from a safe frequency onwards, there is a point in the amplifier at which the drive voltage or current increases with 6 dB per octave at a given drive level. We have already found this 'point': the drive current through C_N and C_P, or the drive voltage over R11 and R13 which amounts to the same thing. To put it another way: the frequency-dependent *input* characteristic of the MOSFET output stage T11 . . . T14, which is present in any case, is used for

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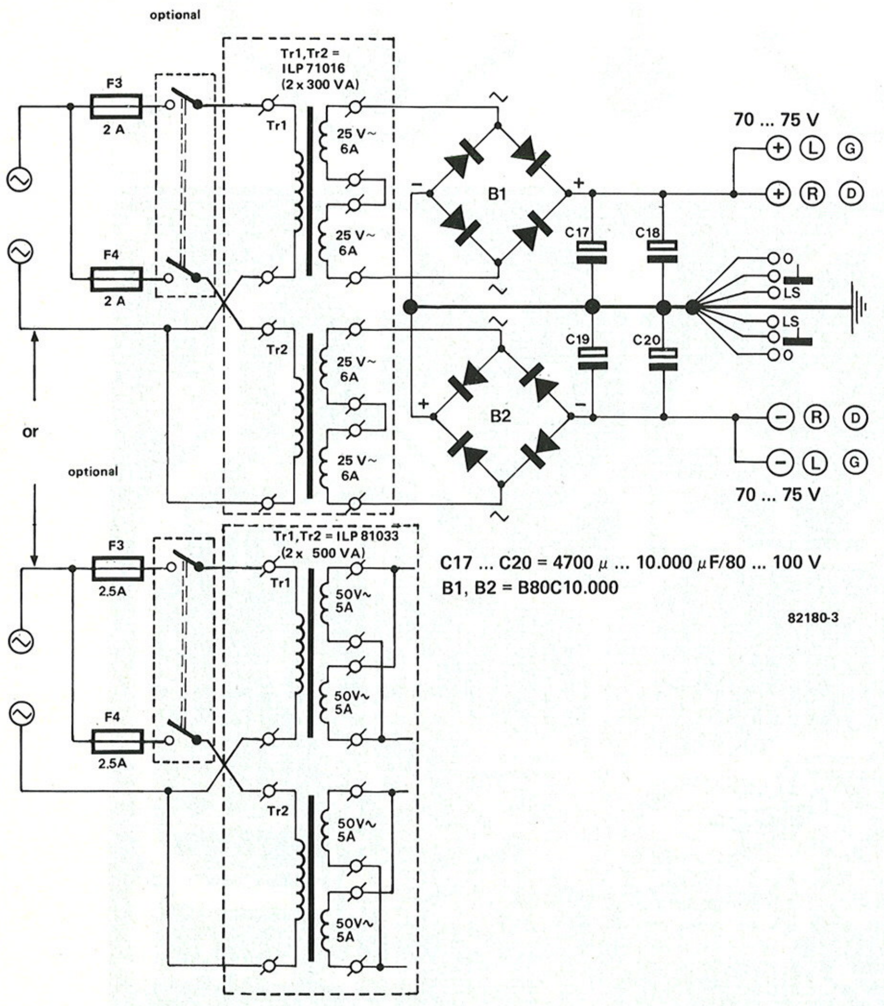
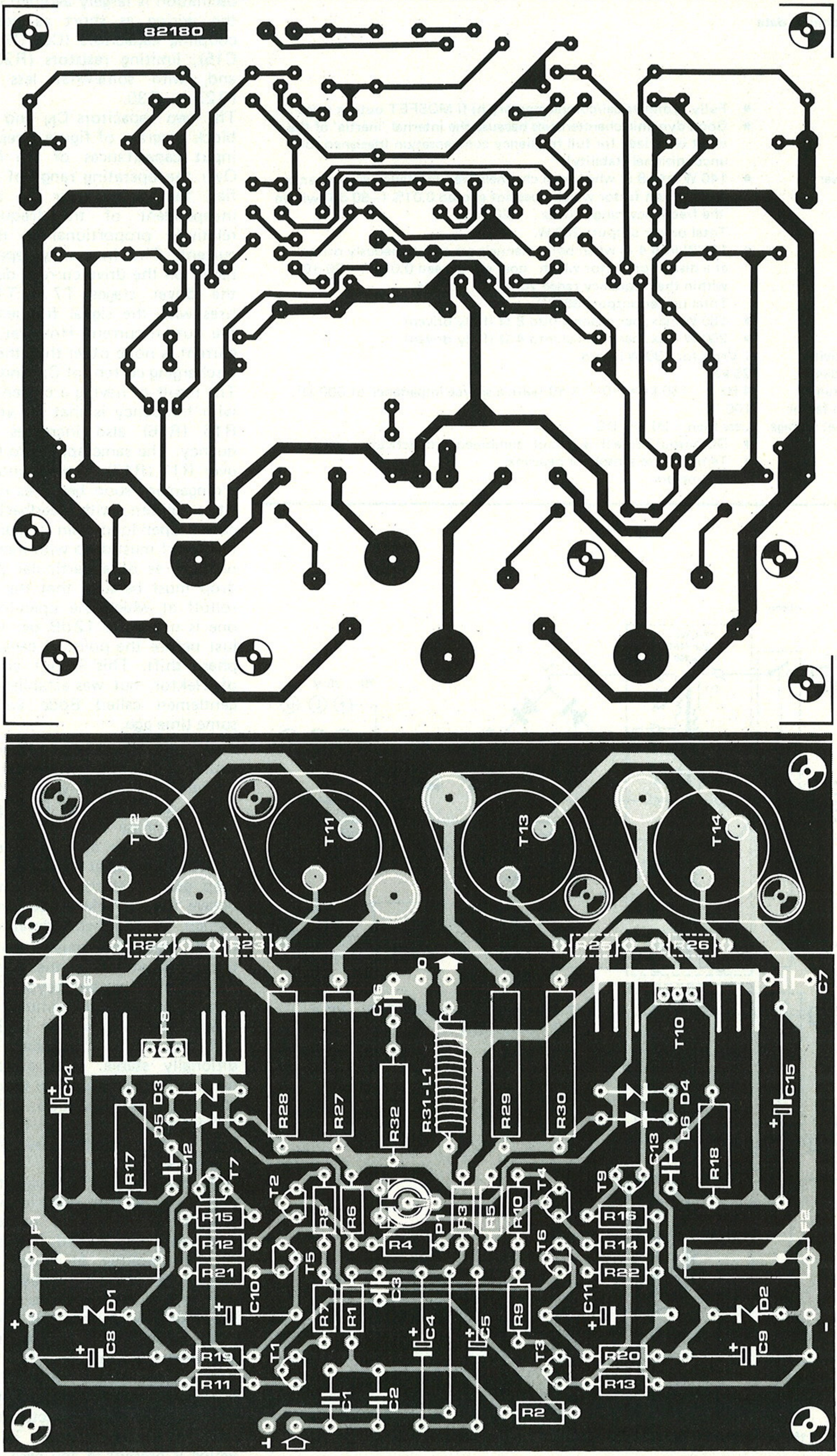


Figure 3. This is the hefty power supply for the amplifier.

4


82180
T12
T11
T13
T14
R24
R23
R25
R26
C6
C7
C16
0
T8
T10
C14
C15
D3
D4
D5
D6
R28
R27
R32
R31-L1
R29
R30
R17
R18
C12
C13
T7
T2
R8
R6
P1
R3
R5
R10
T4
T6
T9
R15
R16
R12
R14
R4
R21
R22
F1
F2
T5
C10
C3
C11
D1
D2
R7
R1
C4
C5
R9
+
-
C8
C9
R19
R20
T1
T3
R11
R13
C1
C2
R2
⊥

Parts list

Resistors:
R1 = 27 k
R2 = 3k9
R3 = 10 Ω
R4 = 1 k
R5 = 150 k
R6 = 39 k
R7 . . . R10 = 150 Ω
R11 . . . R14 = 6k8
R15,R16 = 82 Ω
R17,R18 = 10k/1 W
R19,R20 = 2k2
R21,R22 = 5k6
R23 . . . R26 = 220 Ω
R27 . . . R30 = 0,22 Ω/5 W
R31 = 1 Ω/1 W carbon film
R32 = 10 Ω/1 W carbon film
P1 = 250 Ω preset

Capacitors:
C1,C2 = 820 n MPF*
C3 = 220 p ker.
C4,C5 = 220 μ/10 V
C6,C7 = 220 n MPF*
C8 . . . C11 = 100 μ/10 V
C12,C13 = 330 n MPF*
C14,C15 = 100 μ/100 V
C16 = 22 n MPF*
*MPF = metallized plastic foil

Semiconductors:
D1,D2 = zener diode 3V9/0,4 W 5%
D3,D4 = zener diode 12 V/0,4 W 5%
D5,D6 = 1N4148
T1,T2,T6 = BC546A
T3 . . . T5 = BC556A
T7 = BC560C
T8 = BF470
T9 = BC550C
T10 = BF469
T11,T12 = 2SK135 (Hitachi)
T13,T14 = 2SJ50 (Hitachi)

Miscellaneous:
L1 = approx. 2 μH, 2 x 10 turns
Copper enamel (dia. 1mm) on R31
F1,F2 = 3.5 A fuses, slow-blow, with p.c.b. fuse holders
Two heatsinks for T8 and T10 (e.g. SK09/ 37.5 mm; approx. 8.5° C/W)
One heatsink for T11 . . . T14 (e.g. SK53/ >150 mm, black anodised, not predrilled (see figure)
Aluminium angle section 40 mm x 40 mm, 180 mm long (see figure and figure)
Mounting and isolating hardware for T11 . . . T14 (see figure)
Thermolube
Power supply (without printed circuit board):
B1,B2 = bridge rectifiers 100 V/25 A (see figure)
C17 . . . C20 = 4700 . . . 10000 μ/80 . . . 100 V or
C17,C19 = 10000 μ/80 . . . 100 V;
C18,C20 can then be ignored.
Preferably can electrolytics with screw terminals.
F3,F4 = 2 or 2.5 A slow-blow fuses
Tr1,Tr2 = mains transformers 2 x 25 V/ 6 A (300 VA) or 2 x 50 V/5A (500 V) toroidal

R 32 = 10 Ω/1 W carbon film
P1 = 250 Ω trimmer potentiometer

Figure 4. Track pattern and component overlay for the power amplifier. The four MOSFETs are also situated on the p.c.b. This is not the simplest solution but certainly the most reliable one.

purposes of frequency compensation. We can be greatful for the very high, overall collector impedance of the cascade T7 . . . T10 which makes this possible.

Why is this advantageous? The 'inertia' of C_N and C_P is present in any case, whether it is used for compensation or not. The alternative would be complete or additional compensation elsewhere in the amplifier. This would mean that a Miller capacitance would have to be added to the circuit of Figure 2. It would provide additional 'inertia' but would also give rise to TIM problems. Let us assume that such a capacitor were present between the base of T7 (T9) and the collector of T8 (T10). The maximum available charging/ discharging current is approximately 300 μA (collector current of T1 or T3). Clearly there will be an audible frequency at which a 'clean' sinewave at the input will result in an equally 'clean' triangular waveform at the output . . . Fortunately, that is not the case with our design.

Those readers who are interested in the slew rate can rest assured that the amplifier does not easily become unstable, in other words it would take a great capacitive load at very high frequencies. With 180 W/10 kHz into 4 Ω the peak value of driver AC is 0.6 mA, although 14 mA are available. In principle the figure is even higher, but the driver stage then changes to class AB. At higher frequencies the AC increases proportionally and reaches a value of 14 mA at a particular frequency. However, the input filter consisting of R2/C3 then becomes effective.

Let us briefly consider some of the components which serve to stabilize the circuit. Firstly, R32 and C16 which are rated so that R32 does not go up in a puff of smoke when the amplifier is tested at full output with 100 or 200 kHz. Bacause of the high self-inductance, R32 must not be a wire-sound resistor. L1 and R31 in parallel partially or fully compensate for the phase shift caused by a capacitive load at the amplifier output. R31 serves for damping the resultant LC circuit so that square-wave reproduction is faithful in this case too.

That completes the description of the output stage. The amplifier requires a power supply to power it from the mains. The power supply is shown in figure 3 and is rated for stereo operation. One transformer and one bridge rectifier are required for each operating voltage. Two channels are thus provided with a common positive and negative rail. However, there is no risk of crosstalk between the two channels, and certainly not via the power supply. As already mentioned, interference to the operating voltages does not impair operation of the amplifier. It is preferable to use toroidal transformers in the power supply. The constructor can choose between a medium-rating power supply (600 VA) and a high-rating power supply (2-times 500 VA). The choise depends on the amound budgeted and on whether the amplifier is going to be 'pushed' into a load of 4 Ω. The DC smoothing also requires a little thought. The minimum is 4700 μF and the maximum is 10000 μF per operating voltage and per channel. The maximum values for C17 . . . C20 are not only governed by the cost, but are also a matter for technical consideration. The 'bigger' the capacitors, the lower is the 100 Hz hum and the greater are the charging current peaks.

The technical data in table 1 apply to the medium-rating power supply with minimum smoothing.

When the amplifier is switched on, the output voltage will initially contain a DC component. This is because the feedback is not immediately effective. Also, electrolytic capacitors C8 and C9 require a certain time before they are charged up to the zener voltage of D1 (D2).

There is one more situation in which the DC voltage can be present at the amplifier output: this is in the event of an overload on the output stage, if fuses F1 and F2 do not blow or do not blow simultaneously. This voltage and the 'starting voltage' already mentioned can be hazardous to our expensive loudspeakers. For this reason it is a good idea to equip this amplifier with a DC protection and activation-delay circuit, which is also suitable for other amplifiers. For reasons of space, we will discuss such a circuit in the next issue of the magazine.

Construction

When wiring an amplifier to its power supply it is easy to make mistakes that can impair the audio performance. We therefore recommend that the following text and the corresponding illustrations be followed closely.

One difficulty has already been removed: figure 4 shows a printed ciruit board layout. The cost of this p.c.b. is negligible compared to that of the power supply and the MOSFETs. For this reason we strongly recommend that only this p.c.b. be utilized. Even very slight interaction between the output and inputs of the cascades on the one hand and the 'wiring' of the MOSFETs of the p.c.b. on the other hand are critical.

The method applied to position the MOSFETs directly on the p.c.b. is not the simplest way, but has proven to be the most reliable one. Although a few holes have to be drilled in a heatsink for the transistors, this is far preferable to positioning the MOSFETs on a heatsink away from the p.c.b.; the resultant wiring would very probably cause the output stage to oscillate. Our arrangement may be unusual, but it is much more reliable. Those familiar with Murphy's Law will know that 'Amplifiers always oscillate, oscillators often fail to oscillate'.

5

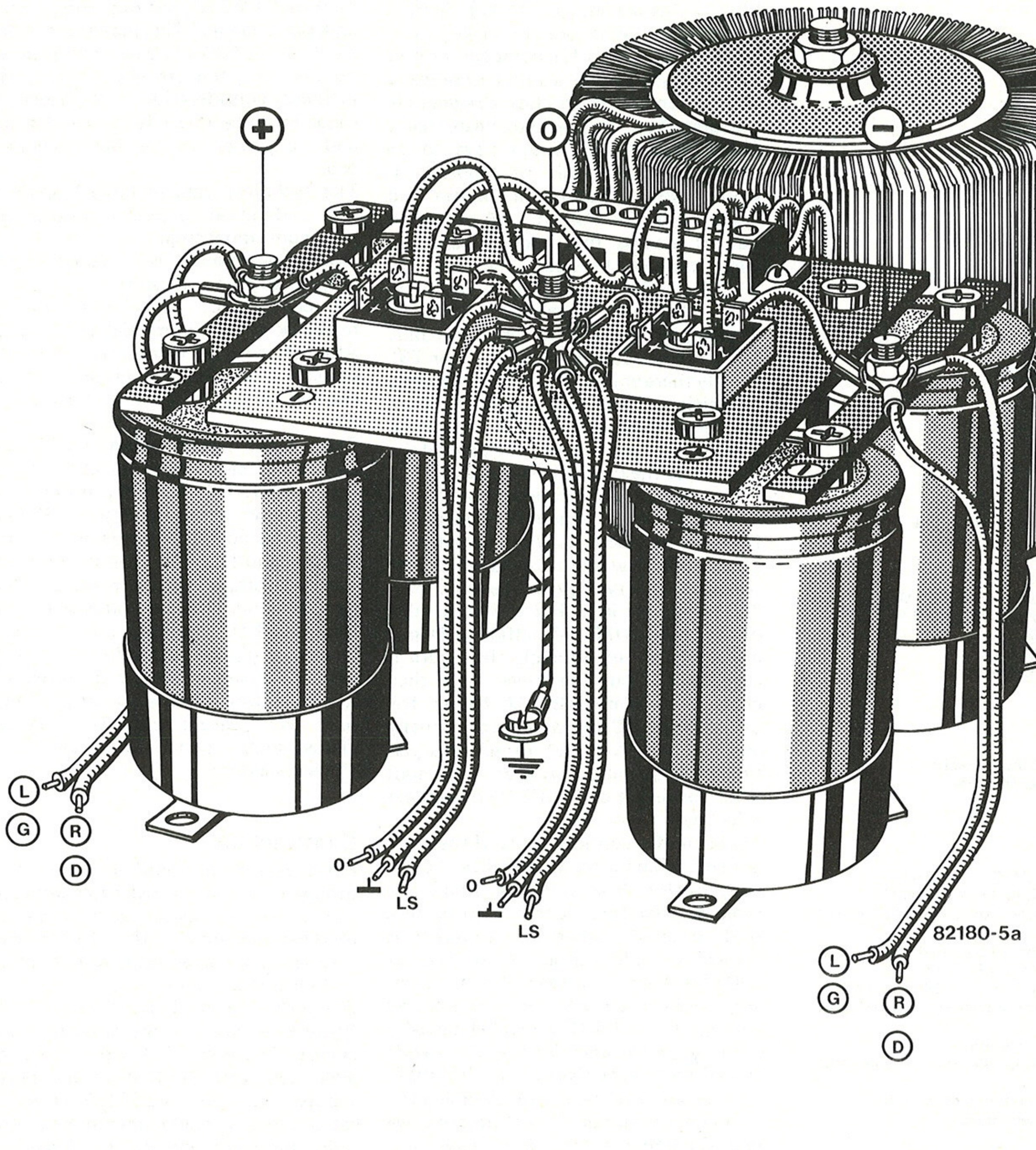


Figure 5. A possible power supply arrangement.

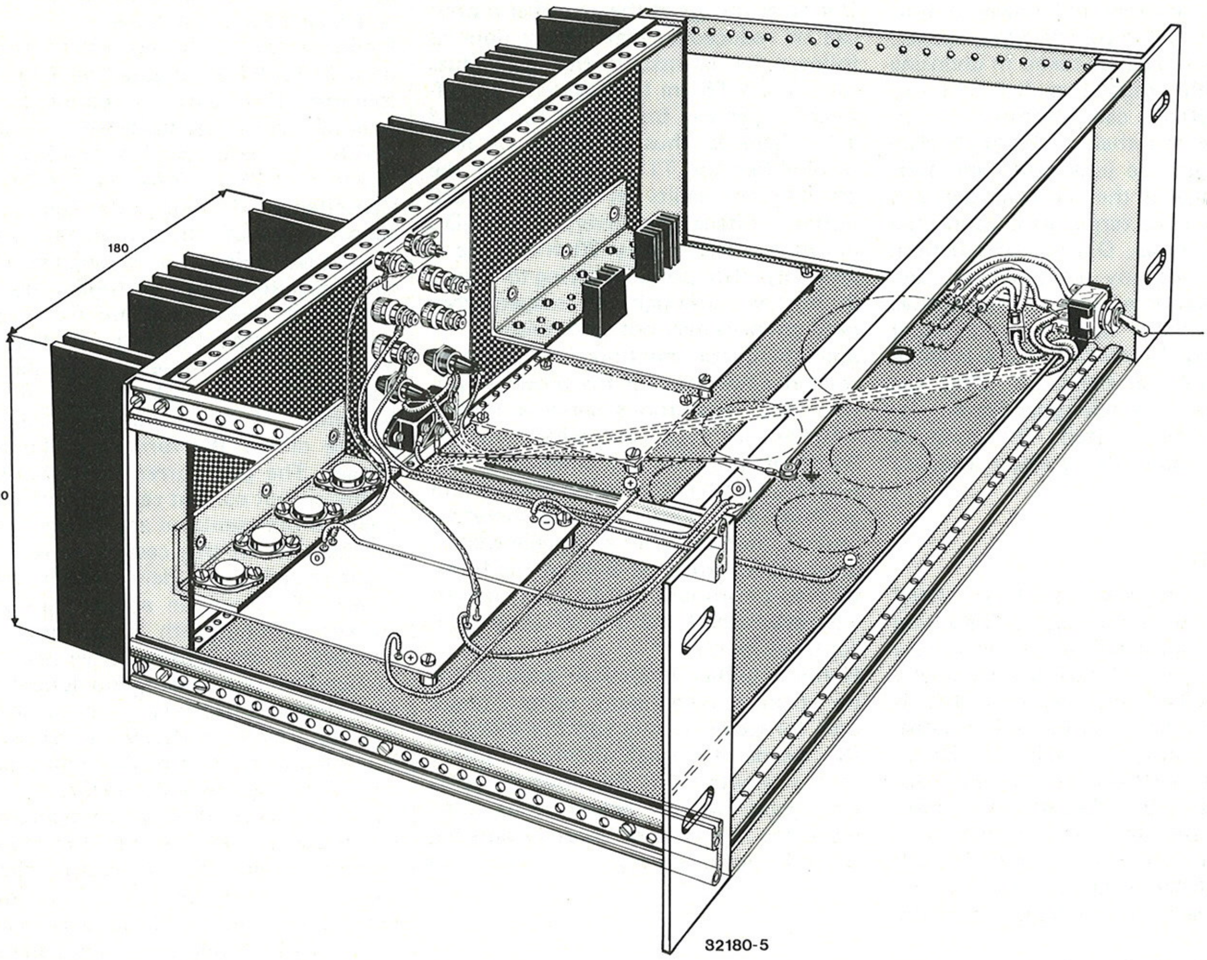
We shall tackle the mounting of components on the p.c.b. first. All components are inserted except for T11 . . . T14 and R23 . . . R26. R27 . . . R30 must have a little clearance from the p.c.b. when soldered in. This provides the resistors with some cooling. The enamel must be carefully removed from the ends of coil L1 so that a good electrical connection is made with R31 when soldering. As soon as P1 has been inserted, it should be rotated fully anticlockwise to avoid any problems later.

If the amplifier is to be trimmed to minimum DC output offset (more about this later), it is better to use transistor sockets for T1 . . . T4, and insert the transistors later.

The heatsinks for T8 and T10 (see figure 6b) are positioned vertically. The heatsink for T10 must not make contact with the lead of C7 which is very close to it. It is advisable to try this out visually before drilling a mounting hole for T10 in its heatsink.

We must not forget the wire link (input ground). On the component side, the pins of T1 . . . T7 and T9 should not be longer than 4 mm. We now turn to the positioning of T11 . . . T14, T23 . . . R26 and the heatsink. First the aluminium bracket is cut to the width of the p.c.b. and then the holes are drilled. This can be done in two ways. When the two mounting holes have been drilled, the aluminium bracket and the p.c.b. can be bolted together and the p.c.b. can be used as a drilling template. Otherwise the drilling diagram in figure 6c should be used. Some precision is required here; T11 . . . T14 must be installed in a fully isolated fashion. A poor fit can cause short-circuits between the metal parts. Finally, the aluminium bracket is mounted on the p.c.b. together with the MOSFETs as shown in figure 6c. It is better to apply too much rather than too little thermolube to each side of the mica insulation. When the assembly is finished, use another ohmmeter to ensure that there is no contact between the TO-3 and the aluminium.

Mechanical assembly is then followed by electrical installation of transistors



An overview showing the assembly consisting of the p.c.b., MOSFETs, bracket and heatsink and some practical details . . .

T11 . . . T14. The gate and drain terminals are simply connected to the appropriate tracks on the soldering side. A solder lug is required for each source terminal. T11 and T12 are the furthest from the right-hand edge of the p.c.b. and T13 and T14 are the closest to it (as in figure 4).

Resistors R23 . . . R26 are drawn with dashed lines in the component overlay of figure 4. They are positioned as closely as possible to the gate terminals of the MOSFETs on the soldering side. There are no mounting holes. The leads of the resistors are cut as short as possible (1 cm maximum), then bent and soldered to the copper surfaces, leaving a clearance between the resistors and the p.c.b.

The p.c.b. with components fitted is now connected to the large heatsink (see figure 6b). The manner in which the two units are assembled largely depends on the housing. Since the heat dissipated by the MOSFETs is transferred to the heatsink via the aluminium bracket, extremely good contact is required between the two. At least six nuts and bolts (M4 x 15, for example) and a generous amount of thermolube between the two metal surfaces will ensure good thermal contact.

If a stereo amplifier is desired, the entire procedure must be repeated.

The housing and power supply are the largest parts of a power amplifier. Figure 5 shows a suggestion for the complete stereo power amplifier. The additional circuitry mentioned is not yet included. However, the wiring will not be greatly changed by adding these extra circuits.

The wiring is fairly critical. Performance of the amplifier can be greatly impaired by accidental metallic contact or inductive or capacitive pick-up. A likely source of interference is pick-up from the operating voltage leads at the input. If the amplifier is driven with a strong sinusoidal signal, the two supply currents look like half-wave rectification with many harmonics. The higher the harmonics, the greater the likelihood that they will be picked up at the input.

Accidental metallic contact is prevented by only having one ground point (at the electrolytic capacitors). The amplifier is provided with an input ground and an output ground which are interconnected internally via R3 and connected externally to the main ground point.

The rating of the power supply depends on various factors: the transformers chosen for Tr1 and Tr2, the smoothing capacitors, the required power output and, of course, the constructor's budget. Some care should be taken in choosing the smoothing capacitors. It is better to use a 4700 µF can electrolytic with screw terminals than a 10000 µF electrolytic from the junk box. Moreover, an advantage of the can electrolytic is that none of the terminals is connected to the metal can. During construction, alignment and any measurement, care must be taken to ensure that the negative operating voltage never makes contact with ground. Figure 5 shows a possible power supply arrangement using can electrolytics. Vehicle-type spade terminals can be utilized. The stranded wire must have the greatest possible crosssection.

Activation

The power supply should be tested before its load is connected. The wiring should be inspected first. An incorrectly wired electrolytic capacitor can actually explode! When the mains switch is turned on, the positive and negative operating voltages should be 70 . . . 75 V. The electrolytics are then discharged again. But do not use a screwdriver; the best method is to employ a resistor of a few kilohms, or a relatively low-impendance voltmeter. In this case one can see the voltage gradually decaying.

The entire amplifier can now be tested. If the stereo version has been built, the instructions in the following text must be followed twice.

First, position all ground leads as shown in the figures and as described. The positive and negative leads from the power supply are then connected to the output stage. Use two 10 Ω, ¼ W resistors temporarily instead of fuses F1 and F2. Quiescent-current trimmer P1 is rotated fully anti-clockwise. The loudspeaker terminals remain disconnected. Now switch on the power supply. Should there be a short-circuit somewhere in the output stage, the 10 Ω resistor will go up in smoke. In this case, switch off the amplifier, find the fault and correct it and insert two new resistors.

When everything is in order, connect a multimeter over one of the resistors (3 V or 6 V DC range, see also figure 2, F1 and F2). The voltage over this resistor should be zero. Otherwise P1 is not at its extreme anti-clockwise setting. The voltage should rise as P1 is slowly rotated. At the setpoint voltage of 2 V, the current through this resitor is 200 mA, i.e. 100 mA per MOSFET.

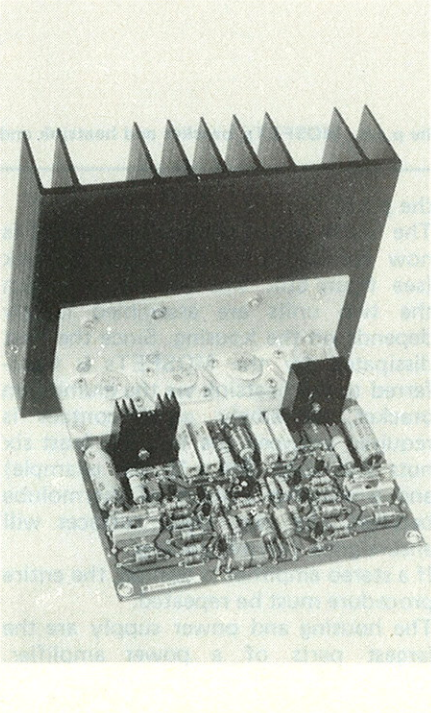
When this adjustment has been made, switch off the amplifier and insert the two fuses F1 and F2. Switch on again and measure the voltage between the amplifier output and ground. It should not exceed 20 mV (positive or negative). The amplifier is now ready for operation. The test points marked in figure 2 can now be checked.

One final voltage at the amplifier output can be reduced further. This is done as follows: let us assume that the values for T5 and T6 are established. Two different types can be utilized for T1 and T3. There is thus a choise of four possibilities for T1 . . . T4. One of the possibilities results in the lowest DC output voltage. However, if the DC output voltage is only 20 mV, there is probably little point in trying to reduce it further, although we suspect that perfectionists may not agree with us.

Something not mentioned up till now concerns the case for the power amplifier. The illustrations show a typical 19 inch rack type case, which is ideal. Some of you may be tempted to use steel plates for the sides top and bottom as these are robust and will therefore protect your amplifier extremely well. Steel reacts with the field of the transformers to produce quite a loud hum, so we recommend the use of aluminium for these items.

If the amplifier is for P.A. applications we strongly recommend using a larger case for extra cooling and the shielding (by means of a small aluminium plate) of the inputs from the power supply. One good way to help matters is to place the inputs as far away as possible from the power supply. ◼

Literature:
Toroidal Transformers
Elektor April 1982



Equivalent circuits

MOSFETs as source-followers

When MOSFETs are utilized in output stages, the P and N-layers and junctions are of less interest than the performance of a combination of resistors, capacitors and voltage or current sources. When considered as a whole, these provide an accurate equivalent circuit of the P and N-layers and junctions.

Figure a shows the equivalent circuit of a MOSFET configured as a source-follower. Resistance r_g represents the internal series resistance of the gate, which is externally 'extended' by resistors R23 . . . R26 in figure 2. Capacitance C represents the input capacitance of the source-follower. The drive voltage u is applied over this capacitor; when multiplied by the slope S, it determines the AC output current through load R_L. In the frequency range of interest, S (frequently denoted Y_{fs}) is independent of the frquency. If the source-follower is voltage driven, the formula of figure a applies. The gate current contribution i to the output current can be ignored.

Figure b represents an equivalent circuit for figure a. In this case, however, the input impedance is demonstrated more clearly. The formula applies purely to current driving with a current i. In contrast to the voltage drive assumed in figure a, resistance r_g no longer has any influence. However, the maximum level to which the device can be driven is limited as a result of the voltage drop over r_g and by the base resistor.

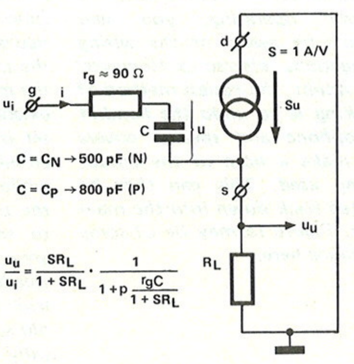
The ideal current drive of figure b is not found in practice. For this reason, figure c shows an equivalent circuit which is more realistic. The joint, design-related effect of the two cascades T7 . . . T10 of figure 2 is contained in the current source i_s and resistance R. R represents the joint collector resistance of T8 and T10. The formula exhibits a certain frequency-dependence which leads to the automatic, inherent frequency compensation for unconditional stability as mentioned in the text. The necessary rolloff of 6 dB per octave is found in the relationship between the output voltage and the sum of the cascade input voltages.

A given open-loop gain is associated with a particular cutoff frequency W_{3dB}. The higher the one value, the lower is the other. The fact that the frequency compensation of the amplifier can take place entirely in the combination of driver stage and output stage (i.e. no other capacitors are required, with all their disadvantages), results from the use of the cascade circuitry. The circuit provides a high resistance R and ensures that no series capacitance is connected between output and inputs. Incidentally, if true current drive were utilized as assumed in figure b, the total effect of the driver stage and output stage would be an integrating one. We would then have a cutoff frequency of 0 Hz. Of course, this would not be satisfactory. Suppression of distortion and interference, effective as a result of the feedback, must be frequency-independent over the largest possible frequency range.

So far we have only dealt with one source-follower (fugures a . . . c). In reality, however, there are four such devices (T11 . . . T14 in figure 2.) Hence the equivalent circuit of figure d. At low drive, all four MOSFETs conduct; at high-level drive, either T11 and T12 or T13 and T14 conduct.

In figure d the time constant $1/W_{3dB}$ is established by the product of R and parallel connection (sum) of the four capacitors. It should be noted that if two MOSFETs turn off and the other two conduct, there are two small capacitances (i.e. the 'conducting' capacitances for which $S \neq 0$) and two large capacitances pertaining to the MOSFETs which are turned off. Capacitance C_N is not exactly equal to C_P. This means that the output stage is not fully symmetrical. However, there is no point in inserting the differential capacitance somewhere between the gate and the source, particularly since resistance r_g cannot be removed from the MOSFET chip. Capacitances C_N and C_P exhibit a strange response. At low values of gate-source voltage U_{GS}, C_N and C_P greatly depend on this voltage. If their response curves were drawn as a function of U_{GS}, the result would be a deep notch in the flat line: this notch would be in the region of $U_{GS} = 0$, whilst the characteristic would be almost flat at high positive and negative values of U_{GS}. The depth of the notch can also be assigned a value. For C_N it is approximately 270 pF and for cp approximately 160 pF 'in depth'. As a result of the quiescent current setting, these two characteristics shift in such a way that the notch becomes more of a 'ditch' which is almost horizontal at the bottom. This means that as of a particular drive level, the driver stage must not only supply or draw the 'normal' current i = C x dU/dt but also the current U x dC/dt. This performance can be observed using an oscilloscope connected over R15 or R16 (the oscilloscope chassis must be floating), with a high drive level and by adjusting the quiescent-current trimmer P1. The practical, negative results for linearity at high-level drive and high signal frequencies can be ignored. However, we should point out that the problem can be solved by using three MOSFETs for each half of the output stage. The changes in U_{GS} (i.e. the six AC voltages u over C in figure a) are then only effective at the bottom of the wide 'ditch'. ◼

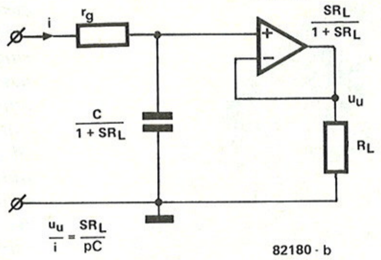
a



$$\frac{u_u}{u_i} = \frac{SR_L}{1 + SR_L} \cdot \frac{1}{1 + p\,\frac{r_gC}{1 + SR_L}}$$

82180 - a

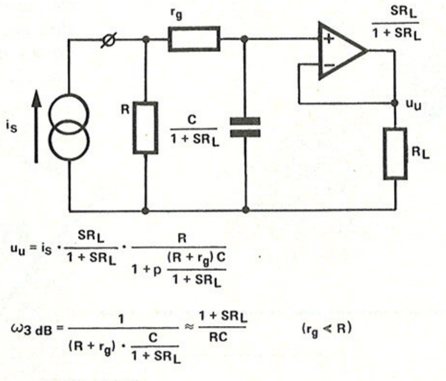
b



$$\frac{u_u}{i} = \frac{SR_L}{pC}$$

82180 - b

c



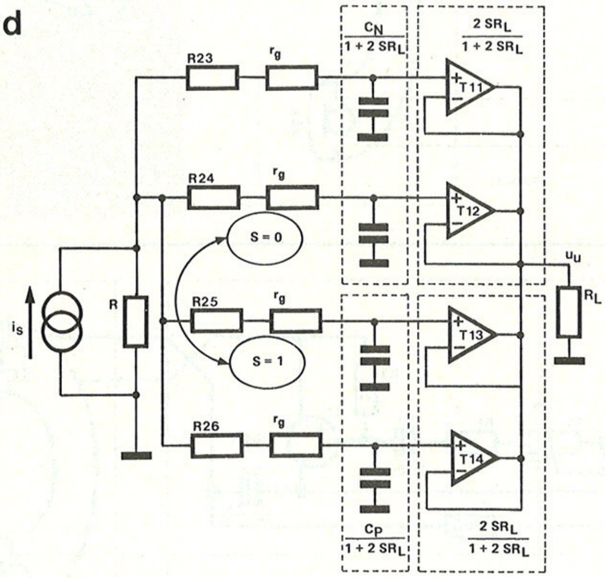
$$u_u = i_S \cdot \frac{SR_L}{1 + SR_L} \cdot \frac{R}{1 + p\,\frac{(R + r_g)\,C}{1 + SR_L}}$$

$$\omega_{3\,dB} = \frac{1}{(R + r_g) \cdot \frac{C}{1 + SR_L}} \approx \frac{1 + SR_L}{RC} \qquad (r_g < R)$$

$$i_S \approx \frac{u_i\,(T7)}{R15} + \frac{u_i\,(T9)}{R16}$$

82180 - c

d



82180-d

home telephone help

technical answers

Speak up, you're through!

This short article is aimed at those readers who have found a use for the home telephone published in the September issue of Elektor. Some readers have expressed a desire to improve the volume level of the speaker in the handset. There is one, very quick and easy answer to this problem. This simply consists of replacing R6 on the printed circuit board of each extension with a wire link. This will serve to increase the output level but, in this case, simple is not quite the best! Unfortunately, the quality of the speech signal can suffer badly. Our good friends at British Telecom are able to use line amplifiers to retain speech quality (we have this on good authority!). This answer is not available to us unfortunately, since the cost for the complete system would probably treble.

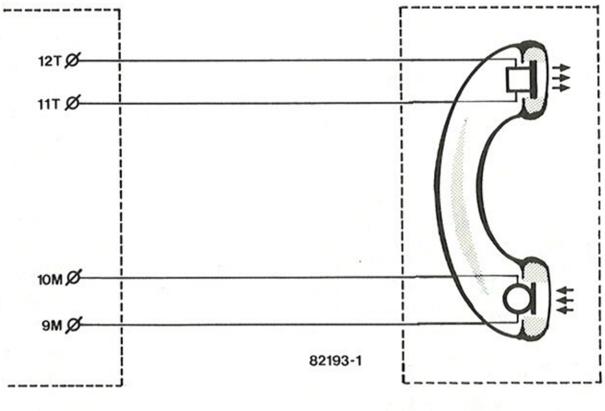
We do have an answer though!

The modification we have arrived at entails the addition of a single transistor amplifier stage (a sort of mini line amplifier). One of these is needed in each extension. The circuit is very small, physically, it can be assembled on a piece of Vero board measuring only 2 x 2 cm.

Figure 1b illustrates how the mini line amp can be fitted into the handset of the extension. Obviously the tag numbering system used (see figure 1a) may differ depending on the type of telephone in use. If your system is already operating, you will already be aware of the wiring connections referred to. However, if in doubt, the easiest method of checking is to undo the handset microphone and speaker covers and make a note of the colour coding used. This can then be tracked back down into the main body. Figure 1a may be of some assistance here.

In order to prevent the possibility of feedback the connections to the speaker should be exchanged (reversed phase) as shown in figure 1b. The power supply for the mini line amp is derived from the microphone line as a dc voltage exists at this point when the handset is lifted. The emitter of T1 is connected to the negative line while resistor R2 is connected to the positive. Care must be taken to ensure that connections here are correct.

Readers have advised us of problems encountered with the use of old surplus type telephones. Basically the pulses generated by the dialling mechanism (in certain cases) are incorrect and the extension dialled fails to respond (no ring out). In the normal course of events, when the hand-set is lifted and the dial is turned the speech line is shorted to earth by means of an internal switch within the dialling mechanism, so in effect you cannot hear what is going on. By disconnecting the appropriate wire from the mechanism (modern telephones it is blue) should solve the problem. You will then hear through the speaker the dialling pulses and eventually the extension dialled ringing.



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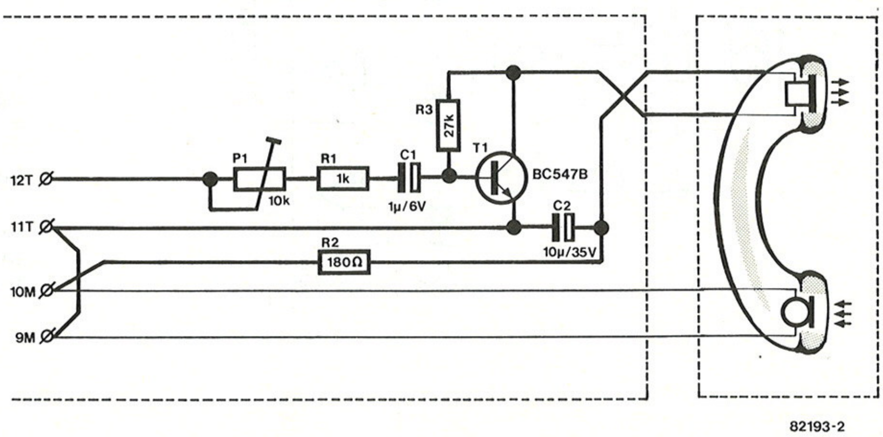

82193-2

Soft switching

improvement to the High Com

based on information from the Telefunken Television and Radio Company, Audio Development

In case the title of this article could be misinterpreted, the purpose of this circuit is not to replace the noisy toggle switches that are typically used in home-made equipment.

This modification provides soft switching by changing the response time of the HighCom circuit to increase the decay time, thus eliminating interference. With this modification the HighCom circuit becomes even better than it was and Telefunken will be offering the improved version as an integral part of the circuitry in future. The HighCom circuit was further refined in the Telefunken development laboratory. The result is an improvement in the form of the auxiliary circuit in figure 1. The track pattern and component layout are shown in figure 2, but we shall discuss this later.

These are the improvements:

1. The distortion factor at frequencies of about 20 Hz is reduced by two thirds. The compander distortion thus becomes noticeably less than band distortion in the audible range. To quote actual figures: the distortion content of the first harmonic of a sinusoidal 20 Hz signal is reduced by about 6% and that of the second harmonic by 3.5%. The total distortion factor with the new version is only 3.31%, compared to 10.38% with the old version. The improvement was achieved by increasing the decay time which is effective during the holding time.
2. Interference caused by very short pulses, such as electrostatic discharges when playing records, is now eliminated by modifying the response time of the circuit. The network for this function now contains two time constants instead of one. This greatly improves the compander's capability and has been demonstrated by the better response time on a sinusoidal 10 kHz burst.
3. Short drop-outs result in undesirable, audible fluctuations in level. The HighCom circuit sometimes responded to these drop-outs with uncontrolled regulating effects. For example, the loudspeakers sometimes exhibited independent audio levels. On the other hand, the type of noise effects in signal pauses that are familiar with other noise suppression systems could not be heard.

Telefunken achieves this performance by controlling the decay with a long time constant during the holding time, followed by a short time constant. However, this automatic changeover between the two time constants was so abrupt that it sometimes resulted in the effects mentioned. Our soft switching circuit eliminates these problems, even with critical signals. There is no doubt that this is a considerable improvement to the HighCom circuit.

The circuit in figure 1 can be constructed on a small vero board or a printed circuit board can be made as shown in figure 2. Terminals 1, 4, 5, 6 and 23 correspond to the pins of the HighCom IC, U401. Solder pins should be inserted at those points. The HighCom module is modified as follows: R6 and C21 are discarded. The value of C7 is changed to 47 n/5% (if this has not already been done). If the module already contains capacitor C7 with this value, the 470 n and 1 k connected in series between pin 1 and pin 6 on the copper track side should be removed. Wire links of about 2 cm in length are now carefully soldered to pins 1, 4, 5, 6 and 23 of the IC. The additional board is then placed on the IC in the HighCom module and the wire links are connected to the solder pins on the printed circuit board.

This completes the modification to the HighCom module and the module can be replaced on the printed circuit board. The result is probably one of the best noise suppression system available. ◼

1

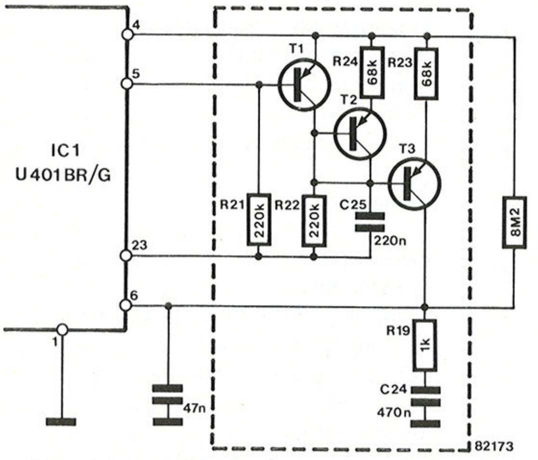

Figure 1. The additional soft switching circuit eliminates interference caused by drop-outs. Additionally, the distortion factor for low-frequency signals and the response time at high frequencies are improved by a slight modification to the HighCom module.

2

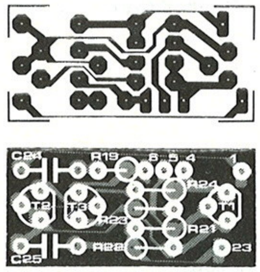

Figure 2. Track pattern and component overlay for the additional board. It is placed on the HighCom IC in the module in piggy-back fashion. When choosing components, please observe the specified tolerances. T2 and T3 should have the same specifications if possible.

Parts list

Resistors:
R19 = 1 k 2%
R21 = 220 k
R22 = 220 k 2%
R23,R24 = 68 k 2%

Capacitors:
C24 = 470 n 5%
C25 = 220 n 5%

Semiconductors:
T1 = BC 557
T2,T3 = BC 557B

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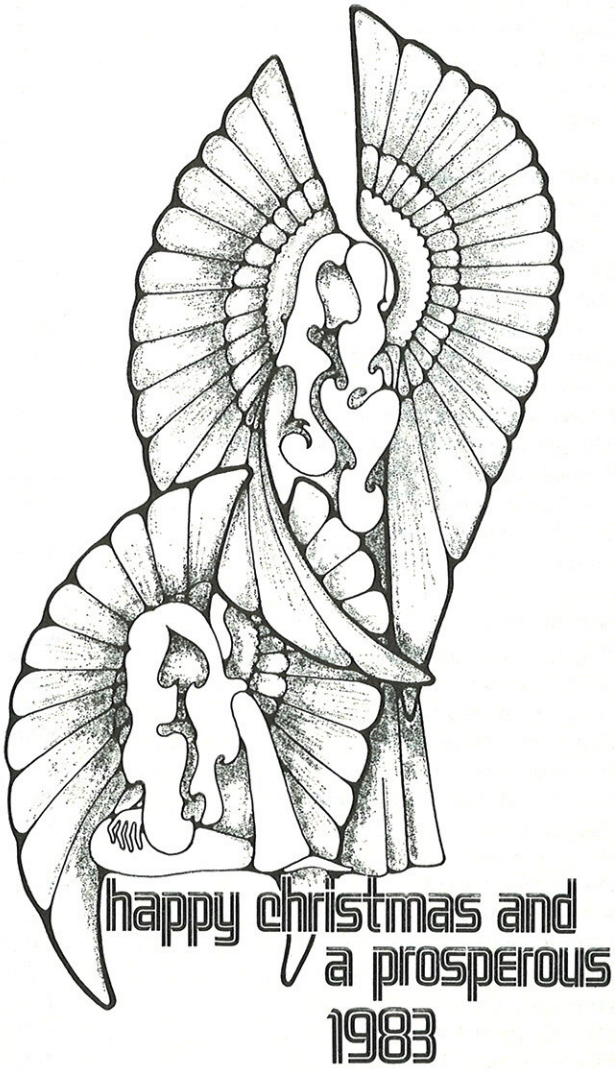


in-car ioniser

fresh air on wheels

The circuit is one way of increasing the concentration of negative ions in the surrounding air, resulting in improved mental concentration, and reaction speed making roads just that little bit safer. At the very least it will refresh the environment.

A theory which has been with us for some time and which is rapidly gaining credence relates to the quantity of negative ions in the air. A high concentration of such ions is both physically and mentally healthy. One element of scientific thought actually states that the quantity of negative ions contained in the air around areas such as St. Moritz is high, which is one reason for the invigorating effect these resorts have on tourists. There certainly seems some truth in these suggestions as negative ion generators are gaining in popularity. Even institutions traditionally known for their ultra-conservative attitude towards new ideas are now using them.

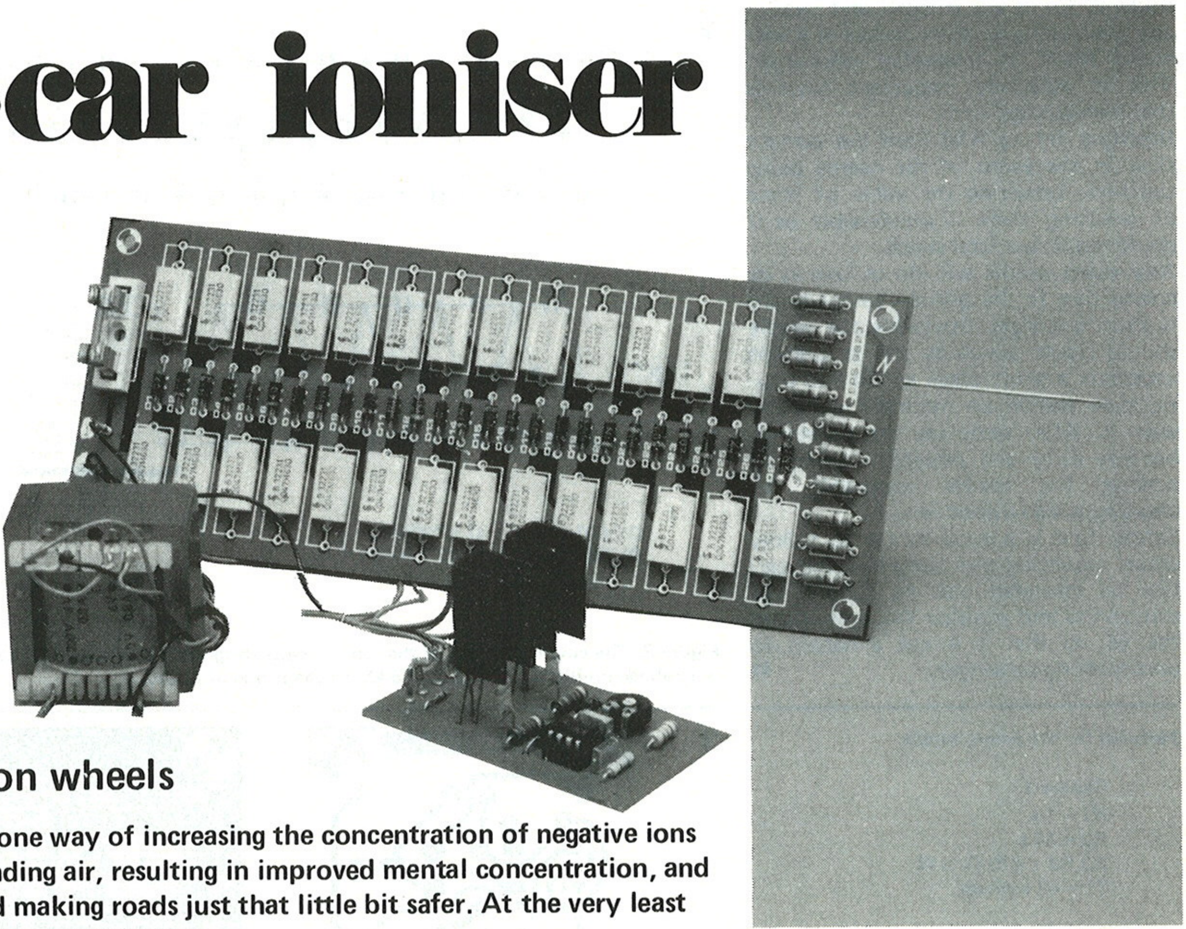
We published a circuit for a domestic ioniser a couple of years ago operated by the mains supply and the idea came to adapt this circuit for use in the car.

The circuit design for a suitable power supply is shown in figure 1. It could be loosely termed as a d.c. to a.c. converter. The 555 timer (IC1) produces a square-wave signal with a frequency around 85 to 100 Hz. The values of R1 and the combination of P1 and R2 have been chosen so that the square-wave produced is symmetrical. This is then fed to transistors T1, T2 and transformer TR1. The result is an a.c. voltage across the two secondary windings of the transformer of approximately 400 V (square wave).

Figure 2 shows the circuit diagram of the ioniser which consists of a 27 stage voltage multiplier, in order to step up the voltage from 400 V to around 7.5 kV. The output is then connected to a sewing needle or something similar.

As most readers already know the electric field strength around a charged body is greatest where the curvature is also greatest, hence a sharp point. An intense field is therefore present at the tip of the needle with electrons being 'sprayed' onto the air molecules negatively charging them. Each batch of negative ions is repelled by the negative charge of the needle point allowing new air molecules to be processed. The result is a constant flow of ions away from the needle which feels very much like a light draught. This in itself will have a refreshing effect upon the driver and passengers without giving consideration to the metabolic benefits of an increased concentration of negative ions.

Keep in mind that apart from generating negative ions the needle will also produce ozone (O_3). This can on the one hand have certain advantages as it oxidises organic gasses. Carbon monoxide for instance, can be reconstituted into carbon dioxide which is far less harmful. However, ozone if breathed in large quantities can cause irritation of the respiratory system, because of its corrosive and therefore poisonous nature. We therefore do not recommend using the ioniser near to asthma sufferers and please remember that for normal use the ventilation system of the car should be reasonably effective.



Construction

The printed circuit board for the power supply is shown in figure 3. There is nothing critical in the assembly and the only calibration needed is to set P1 to its mid position. No provision was made for mounting the transformer onto the board as the size and type will depend on what is easily available.

Although it is possible by changing C1 for a 330 n capacitor to get a 50 Hz a.c. output, we do not advise it. Basically the peak voltage level produced by the circuit using the specified transformer will be far in excess of 240 V, so that 'blowing up' your razor becomes a distinct possibility. The transistors will need small heat sinks. The transformer should have a 220 V primary and two 6 V secondary windings. Its normal function is reversed in this case.

The printed circuit board and component layout for the ioniser are given in figure 4. Great care is needed to mount the components. Make sure all soldered joints are smooth and neat as any protruding wires or spikes of solder could result in unwanted discharges. This is especially important towards the 'high-voltage' end.

Resistors R1 to R10 limit the current flow in the event of the needle being touched. Lowering the value of these or omitting them is unadvisable as it could result in a fatal shock.

Any sharp needle will do as long as its connection to the printed circuit board is short and rigid. Obviously the needle should point outwards and to prevent accidents a short piece of 30 mm plastic pipe should be mounted coaxially with it. After some use the point will become dirty and possibly eroded, so making the needle removable for cleaning is also a good idea.

Safety first is a good motto to follow when mounting the circuit in the car. Use an insulated box to contain the electronics and position the unit within the car so that it is not a hazard to unsuspecting passengers.

Parts list for the power supply

Resistors:
R1 = 1 k
R2 = 47 k
R3,R4 = 470 Ω/½ W
P1 = 47 k preset

Capacitors:
C1 = 150 n
C2 = 10 n
C3,C4 = 560 p

Semiconductors:
T1,T2 = BD 139
D1,D2 = 1N4004
D3,D4 = 27 V/400 mW zener
IC1 = 555

Miscellaneous:
Tr1 = 2 x 6 V/0.8 A transformer
2 heat sinks for the BD 139
S1 = on/off switch

1

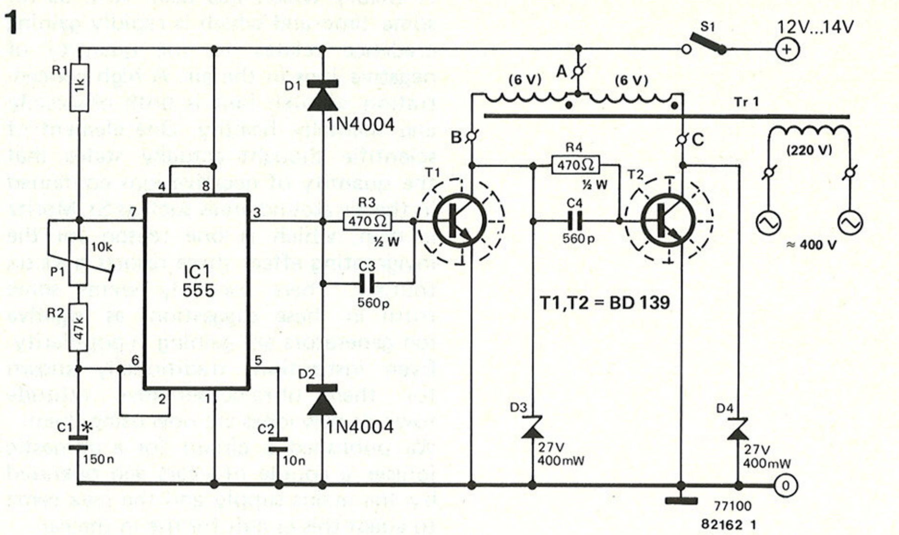


Figure 1. With this circuit the ioniser can be used in the car. With a 12 V d.c. input approximately 400 V a.c. is produced.

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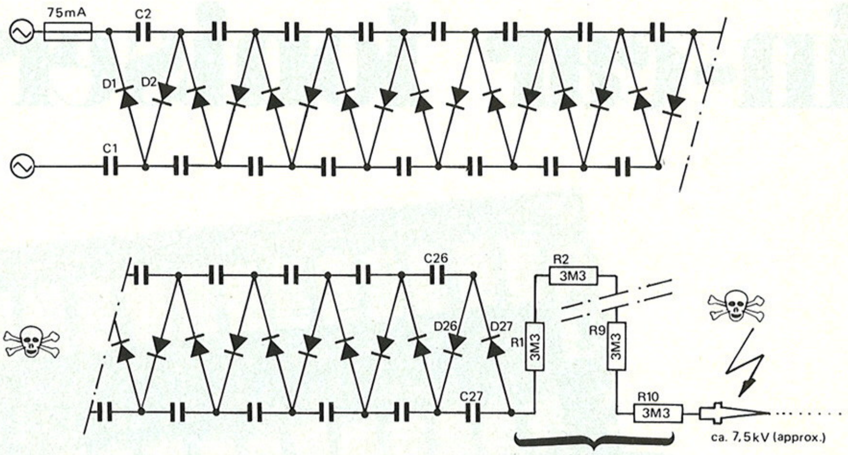


C1...C27 = 33 n . . . 47 n/630 V (27 x)
D1...D27 = 1N4007 (1000 V diode) (27 x)

9823
82162 2

Figure 2. The circuit diagram of the ioniser, consisting of 27 diodes and 27 capacitors. The unit is a voltage multiplier delivering 7.5 kV to the probe or needle.

3

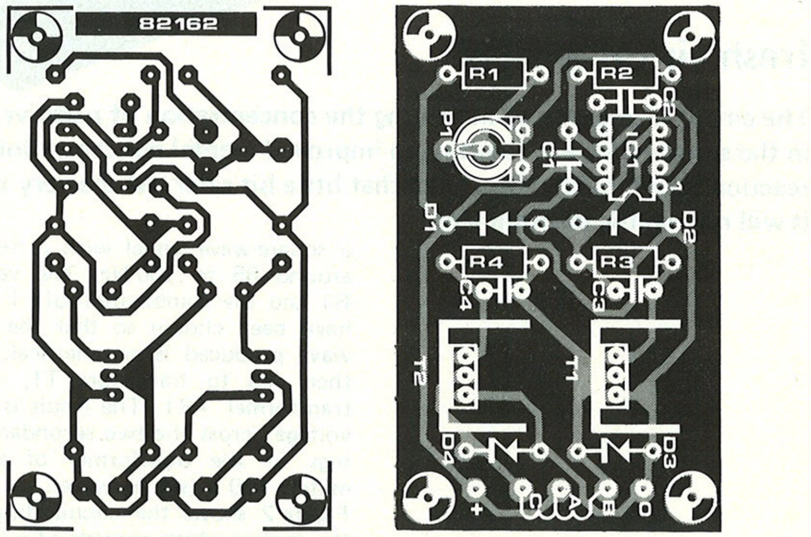


Figure 3. The printed circuit board of the power supply. There is nothing critical in its construction. The transformer uses the 220 V winding as the secondary.

4

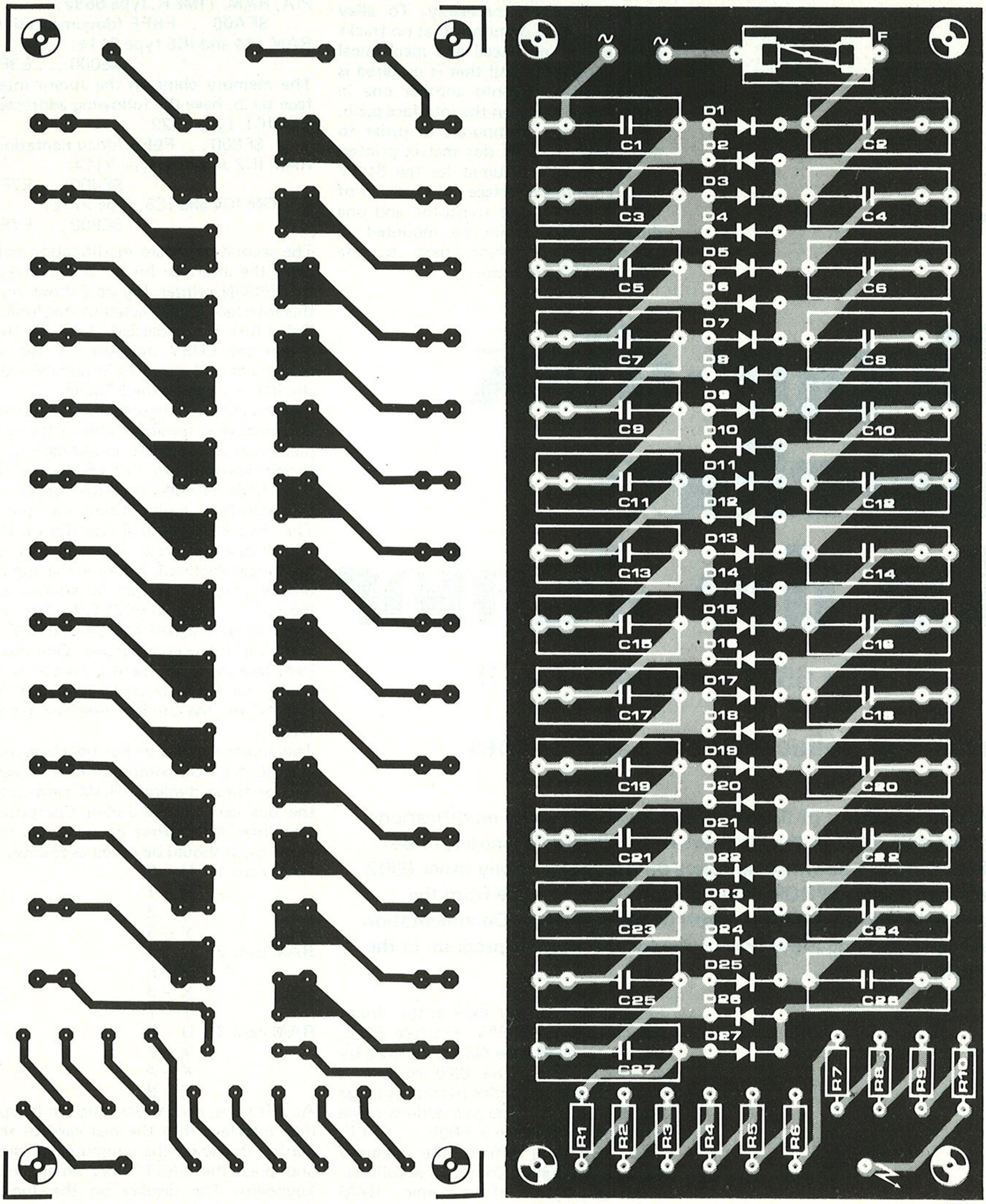


Figure 4. The ioniser board. All the soldered joints and connections have to be smooth and neat in order to eliminate the chances of unwanted discharges.

Parts list for the ioniser

Resistors:
R1 . . . R10 = 3M3

Capacitors:
C1 . . . C27 = 33 n . . . 47 n/630 V

Semiconductors:
D1 . . . D27 = 1N4007 (1000 V)
F = 75 mA fuses

floppy-disk interface for the Junior

. . . and other 6502 computers, Part II

the Junior collects its stars and stripes

G. de Cuyper

The second and last of these two articles describes the modifications that must be made to the hardware of the Junior Computer, to be able to run Ohio Scientific software on the Junior or any other 6502 computer. A new EPROM is required, to load software from the diskette during initialization (reset) of the computer. Documentation is available showing the source listing for the monitor program in the EPROM.

Hardware of the DOS Junior

In order to upgrade the Junior Computer to a DOS computer, certain hardware modifications are necessary. To allay any fears, let us point out that no tracks need be cut nor need any mechanical changes be made. All that is required is to solder an IC onto another one in piggyback fashion on the interface p.c.b. of the Junior Computer. In order to connect an EPSON dot matrix printer, an interface is required for the BUSY line. Since this interface only consists of three resistors, one transistor and one diode, it can easily be mounted in self-supporting fashion next to the V24/RS-232 connector.

Let us take another look in the circuit diagram of the Junior interface p.c.b. (figure 1). NOR gate N33 is replaced by a NAND gate. Line 8K0 or EX is now no longer active in address range $0000 . . . 1FFF. The new address range with the NAND gate is E000 . . . FFFF. This addressing affects the memory chips of the Junior Computer as follows:

- 48 K bytes of dynamic RAM are located in adress range $0000 . . . BFFF. The advantage of dynamic RAM is that it is cheap and has a low current consumption. Three dynamic RAM cards (see Elektor, April 1982) are sufficient to provide the 48 K byte address range for the RAM.
- The address decoder on the standard Junior Computer p.c.b. (IC6) decodes address range $E000 . . . FFFF. The memory chips on the standard Junior Computer p.c.b. are therefore assigned the following addresses:

EPROM IC2, type 2708:
$FC00 . . . FFFF
PIA, RAM, TIMER, type 6532:
$FA00 . . . FBFF (documentation)
RAM IC4 and IC5 type 2114:
$E000 . . . E3FF

The memory chips on the Junior interface p.c.b. have the following addresses:

VIA IC1, type 6522:
$F800 . . . F9FF (documentation)
RAM IC2 and IC3, type 2114:
$E400 . . . E7FF
EPROM IC4 and IC5, type 2716:
$E800 . . . F7FF

The second hardware modification concerns the interface for the BUSY line of the EPSON printer. Figure 2 shows how this interface is connected to the Junior. Relay Re1 is discharded. LED D4 becomes the BUSY indicator in this arrangement and operates in parallel with the BUSY lamp on the EPSON.

The drawings of figures 3 and 4 clarify the hardware modifications. After implementation of these modifications it is only necessary to plug the type 2708 (ESS 515) EPROM into the socket on the standard Junior Computer p.c.b. The two EPROMs IC4 and IC5 on the Junior interface p.c.b. (PM and TM) are no longer required, because the input/output programs for printer control are located in the 2708 EPROM. The address space assigned to IC4 and IC5 is now free for user programs. One more item that must not be forgotten is to fit a wire link between soldering points 'R' and 'S' on the Junior interface p.c.b. (WITH).

The Junior Computer has now been upgraded to a DOS computer. Plug at least two or three dynamic RAM cards into the bus card of the Junior Computer. The lines for address decoding on the RAM cards should be wired as follows:

RAM card 1: U – 0
V – 1
X – 2
Y – 3
RAM card 2: U – 4
V – 5
X – 6
Y – 7
RAM card 3: U – 8
V – 9
X – A
Y – B

At this stage, do not yet plug the floppy disk interface into the bus card of the Junior. Power-up the computer as usual and press the <RST> key on the hex keyboard. The display on the Junior should now light up. The command keys <AD>, <DA>, <+> and <GO> have the same significance as previously. Only the <PC> key has a new function. Once the disk operating system has been loaded into the computer, the DOS command interpreter can be called with the <PC> key. But we shall examine this in more detail later.

Table 1 shows the memory map of the DOS Junior Computer. This memory map also applies to all other 6502 com-

1

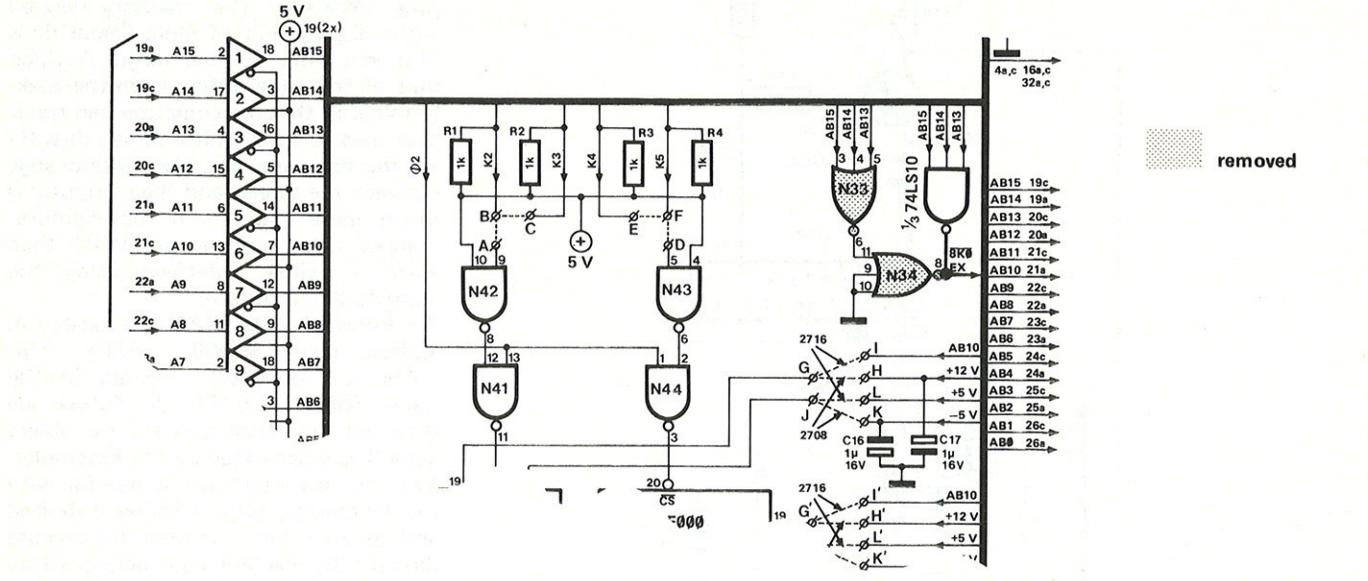


Figure 1. A part of the circuit diagram of the Junior Computer interface card. Gates N33 and N34 are replaced by a 74LS10 NAND gate. This results in a new memory area for the memories on the standard Junior Computer and on the interface card.

puters that are connected to the floppy disk interface. Adresses $C000 . . . FBFF can vary from one computer to another. The only important detail is that the computer must be able to address at least 32 K bytes of contiguous RAM in the lower address range. If, on a computer other than the Junior, the address range FC00 . . . FFFF should already be assigned, the bootstrap software should be relocated to another memory area. This should be relatively simple using the documentation.

Software of the DOS Junior

The software of the DOS Junior Computer is oriented on the latest standards in computer design. This means that the computer is provided with a minimum of ROM intelligence and as much RAM as possible. The advantages of this computer system become clear:

Since the system software, whether BASIC, FORTH, Assembler or a word processor, has to be loaded rapidly from the diskette into the computer, not much space is wasted for the ROM address range. The ROM contains only sufficient intelligence to allow the computer to operate the hex display and keyboard and transmit/receive to and from the Elekterminal. Another function of the ROM intelligence of the Junior is to load track 0 from the diskette into the Junior Computer.

Thus BASIC, Assembler etc. are no longer stored in the ROM but are loaded from the diskette into the computer. This is referred to as 'portable software'. The decisive advantage of portable software is that it can be easily modified. Previously, when software errors were detected or when the system was to be updated, it was necessary to plug a new set of EPROMs into the computer; now with portable software we only need to mount a new diskette on the drive. It is therefore easy to eliminate software errors and the system can be upgraded in keeping with the latest state of the art without difficulty. We make full use of these advantages with the DOS Junior Computer.

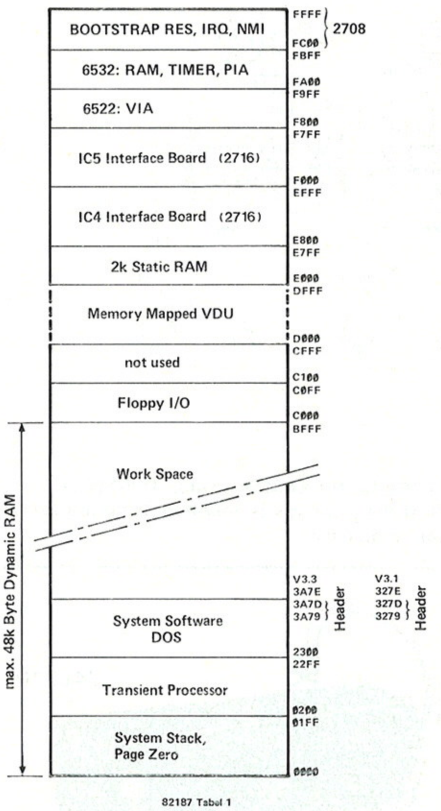


Table 1. The new memory map for the DOS Junior Computer. On account of these extensions the workspace is reduced by 4 K bytes with the OS-65D V3.3. The transient processor overwrites address range $ 2200 . . . 22FF of the DOS software.

Let us examine Table 1 once again. Page 0 and the system stack are located in address range $0000 . . . 01FF. Address space $0200 . . . 22FF is intended for the 'transient processor'. What is a transient processor? This is the software that makes the computer system operable. If, for example, you are working in BASIC, the transient processor is the BASIC interpreter. If you are working in machine language, then Assembler or Ohio Scientific's Extended Monitor is the transient processor.

The system software for controlling the floppy disk drive and the printer, as well as a memory-mapped video display unit takes up about 4 K bytes of RAM. With OS-65D V3.1 the DOS software occupies memory area $2300 . . . 3278. The work space or memory area in which the programmer's own program is stored begins at address $327E . . . When you type a BASIC program into the computer it is stored from address $327E . . . onwards. The data are written into the floppy disk drive from this address onwards. Data which are read from the diskette into the computer are also stored from this address onwards. With OS-65D V3.3 the work space begins at address $3A7E. The first five bytes of the work space are known as the header. These five bytes contain the following information:

1) Start address on the file (2 bytes)
2) End address on the file (2 bytes)

2

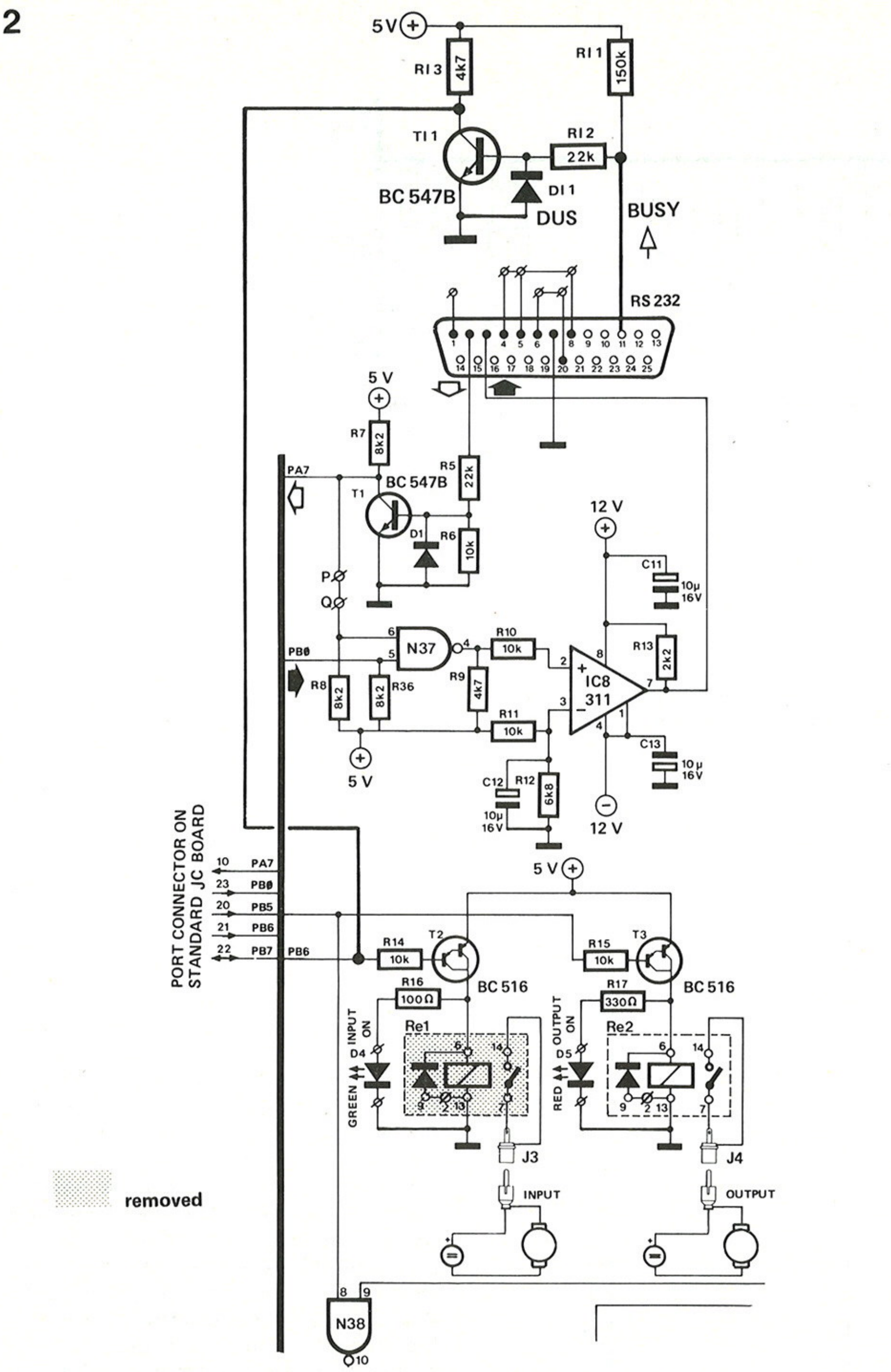


Figure 2. This is how the interface is connected to PB6 for the EPSON printer. If PB6 is a logic 1, the send output (RS-232 connector pin 3) of the computer is inhibited. If no printer is connected, resistor RI1 ensures that the send output is enabled.

3

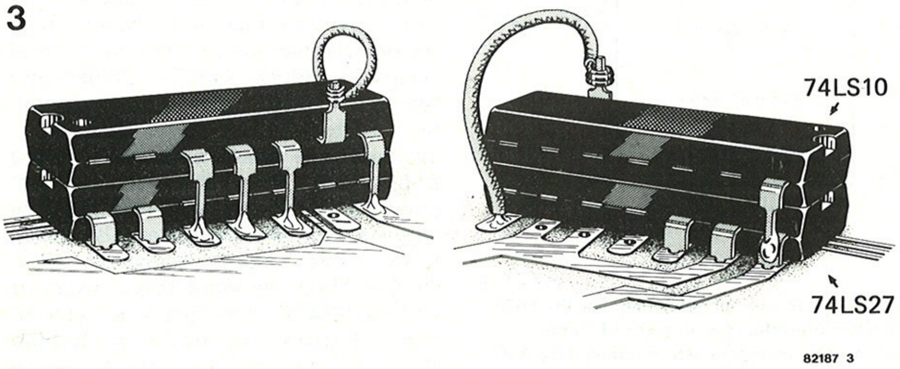


Figure 3. This hardware modification provides the Junior Computer with a new memory arrangement. The drawing shows the 'piggy-back' installation of the ICs.

3) Length of the file in pages (1 byte; 1 page = 256 bytes)

Next to the work space is the 4 K byte page $DXXX. The memory-mapped video display unit of Ohio Scientific is located in this address range. A video unit of this type differs from the Elekterminal in that the computer can transport data to the monitor screen directly via the data bus. The data interchange between the screen and the computer is much more rapid with the memory-mapped video display unit (VDU) than with a video interface using the V24/RS-232 interface.

2 K bytes of static RAM are located in address range $E000 . . . E7FF. This RAM was previously located in the range $0000 . . . 07FF. In future we shall use this RAM area for the object code that is generated by the Assembler. You can now assemble a source file with the Assembler, print a listing if desired and instruct the computer to execute directly the machine code generated by the Assembler. Please consult Ohio Scientific's Assembler Manual for further details.

Adress range $E800 . . . FFFF to IC4 and IC5 on the interface card of the Junior and to the two interface chips 6522/6532 and the 2708 bootstrap EPROM. The two EPROMs IC4 and IC5 on the interface card of the Junior are now freely accessible to the programmer. Personal software or programs which one does not wish to load from the floppy disk into the computer can be loaded into the two EPROMs (2716) for long term applications.

The bootstrap EPROM (ESS515)

The bootstrap EPROM is addressed in the range $FC00 . . . FFFF. It contains only 1 K byte of software. The software in the bootstrap EPROM can be subdivided into eight groups:

1) Hex display monitor. This program is very similar to the original monitor of the Junior. The commands <AD>, <DA>, <GO>, <+> have kept their significance. Only the <PC> key has a different function. The DOS command interpreter can be called directly from the hex keyboard with the <PC> key. The main purpose of the hex display monitor is to be able to modify the software on the Ohio Scientific diskettes. This allows Ohio software to be converted to Junior software.

Important start addresses can be called with the hex display monitor and started with the <GO> key.

- RESBAS * $FF17
- RESDOS * $FF34
- VONE * $FFE2
- VTHREE * $FFE8

2) Loading the BASIC interpreter from the diskette. You can load BASIC from the diskette into the Junior Computer with the command <AD> FF17 <GO> (RUBOUT). To distinguish between command keys on the hex keyboard and Elekterminal keys, we shall

4

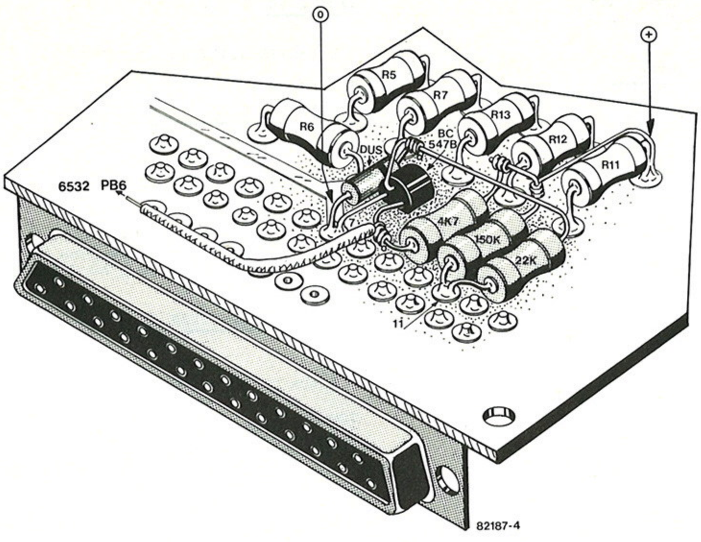


Figure 4. The EPSON interface is placed on the interface card of the Junior Computer as shown here.

write the command keys of the hex keyboard between <> symbols and command keys on the Elekterminal between () brackets in future.

Once BASIC is loaded and the computer has responded on the terminal the transient processor is ready for program interrupts. During output, you can interrupt a BASIC program with the (BREAK) key on the terminal. If the (BREAK) key was pressed during a LIST command, the BASIC interpreter prints 'Break'. If you have started a BASIC program with the RUN command and wish to stop output of the program, simply press the (BREAK) key. The BASIC interpreter responds with 'BREAK IN LINE X'. All program variables and pointers are then saved in the stack. You can restart the program after the interrupt with the CONT statement. The indirect jump vector for the (BREAK) key is automatically set by the computer via address $FF17 when the BASIC program is started. The break vector is stored in address $FA7C and $FA7D.

3) Loading of DOS software from the diskette. In future you can load ELEKTOR's own software into your Junior Computer with the command <AD> FF34 <GO> (RUBOUT). The address DOS is intended for future expansions and 'non-Ohio-software'.

4) Adapting an OS-65D V3.1 Ohio diskette.

An OS-65D V3.1 Ohio Scientific diskette can be adapted to your Junior Computer with the command <AD> FFE2 <GO> (RUBOUT). When the monitor is started at the address VONE * $FFE2 the following occurs:

- The computer positions the read/write head of the drive on track D.
- The computer reads the data on track 0 and stores these data at address $2200 . . . in the memory.
- The computer positions the read/write head of the drive on track 1.
- The computer reads the data on track 1 and stores these data at address $2A00 . . . in the memory. The entire disk operating system is now loaded in the computer and can be modified by the programmer with the hex keyboard.
- Once track 0 and track 1 have been loaded into the computer a jump is made to the hex display monitor and the computer responds with *Track 0&1* on the printer.

5) Adapting an OS-65D V3.3 Ohio tutorial disk 5.

An OS-65D V3.3 Ohio Scientific tutorial disk 5 can be adapted to your Junior Computer with the command <AD> FFE8 <GO> (RUBOUT). For track 1 and track 1 the same applies as under 4). However, once track 0 and track 1 have been loaded into the computer the following occurs:

- The computer moves the read/write head of the drive to track 6. The data on track 6, sector 2 are read into the memory from address $3200 . . . onwards. Sector 2 is one page long.
- The data on track 6, sector 3 are read into the memory from address $0000 . . . onwards. Sector 3 is one page long.
- The computer removes the read/write head of the drive to track 13. The data on track 13, sector 1 are loaded into the computer from address $3A79 . . . onwards. Sector 1 of track 13 is eight pages long. When all tracks have been loaded into the computer the message *Track 0&1* is issued, as with OS-65D V3.1, and a jump is made to the hex display monitor.

6) The <PC> key

You can leave the hex display monitor and jump to the DOS command interpreter with the <PC> key. Printer I/O is initialized but no new baud rate measurement is made. The computer responds with the prompt A* or B*, etc..

7) Printer input routine.

The printer input routine receives a character from the terminal. The received ASCII character is in the accumulator of the CPU after the return from the input subroutine. Bit 7 of the character is always a logic zero. The contents of the index registers are not affected

5

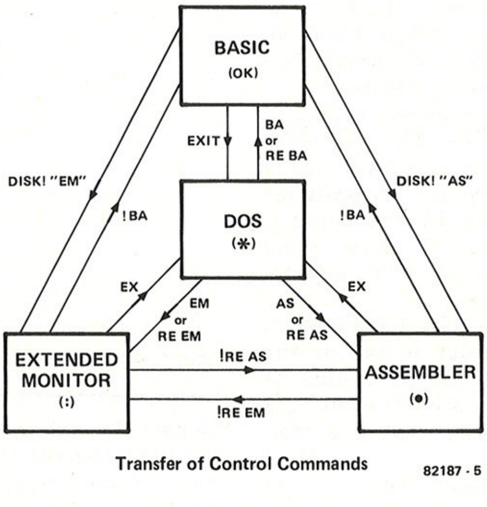


Figure 5. The command transfer to the different transient processors: from BASIC to ASSEMBLER, from ASSEMBLER to EXTEND MONITOR, etc. and vice versa. The 'control centre' is the DOS. It allows the BASIC, ASSEMBLER and EXTENDED MONITOR transient processors to be loaded from the diskette into the computer.

by calling this subroutine. The start address of the printer input routine is:
RECCHA* $FE1B (call: JSR RECCHA).

8) Printer output routine.

The printer output routine sends the character in the accumulator of the CPU to the terminal. The transfer format is:
- one start bit
- seven data bits
- no parity bit
- two stop bits

The contents of the index registers are not affected by calling this subroutine. The start address of the printer output routine is:
PRCHA* $FEA3 (call: JSR PRCHA).

```
<RST>
<AD>    FFE2
<GO>

(RUBOUT)

*TRACK 0&1*

<AD>    2217
<DA>    4C
<+>     40
<+>     22

<AD>    2245
<DA>    4C
<+>     76
<+>     22

<AD>    2283
<DA>    4C
<+>     A6
<+>     22

<PC>

A*CA 0200=13,1
```

Table 2. Adapting an OS-65D V3.1 diskette to the Junior Computer (Part 1), if only one drive is available.

```
A*IN
ARE YOU SURE?Y
A*GO 0200

- DISKETTE UTILITIES -

SELECT ONE:
1) COPIER
2) TRACK 0 READ/WRITE
? 2

- TRACK ZERO READ/WRITE UTILITY -

COMMANDS:
Rnnnn - READ INTO LOCATION nnnn.
Wnnnn/gggg,p - WRITE FROM nnnn FOR p PAGES
               WITH gggg AS THE LOAD VECTOR
E - EXIT TO OS-65D

COMMAND? W2200/2200,8


- TRACK ZERO READ/WRITE UTILITY -

COMMANDS:
Rnnnn - READ INTO LOCATION nnnn.
Wnnnn/gggg,p - WRITE FROM nnnn FOR p PAGES
               WITH gggg AS THE LOAD VECTOR
E - EXIT TO OS-65D

COMMAND? E

A*HOME

A*SA 01,1=2A00/8
```

Table 3. Adapting an OS-65D V3.1 diskette to the Junior Computer (Part 2).

```
A*CA 4000=02,1
A*CA 4800=03,1
A*CA 5000=04,1
A*CA 5800=05,1
A*CA 6000=06,1
A*CA 6800=07,1
A*CA 7000=08,1
A*CA 7800=09,1
A*SA 02,1=4000/8
A*SA 03,1=4800/8
A*SA 04,1=5000/8
A*SA 05,1=5800/8
A*SA 06,1=6000/1
A*SA 07,1=6800/8
A*SA 08,1=7000/8
A*SA 09,1=7800/5

A*CA 4000=10,1
A*CA 4800=11,1
A*CA 5000=12,1
A*CA 5100=12,2
A*CA 5200=12,3
A*CA 5300=12,4
A*CA 5800=13,1
A*CA 6000=14,1
A*CA 6800=15,1
A*CA 7000=16,1
A*CA 7800=17,1
A*SA 10,1=4000/8
A*SA 11,1=4800/8
A*SA 12,1=5000/1
A*SA 12,2=5100/1
A*SA 12,3=5200/1
A*SA 12,4=5300/1
A*SA 13,1=5800/5
A*SA 14,1=6000/8
A*SA 15,1=6800/8
A*SA 16,1=7000/8
A*SA 17,1=7800/8

A*CA 4000=18,1
A*CA 4800=19,1
A*CA 5000=20,1
A*CA 5800=21,1
A*CA 6000=22,1
A*CA 6800=23,1
A*CA 7000=24,1
A*CA 7800=25,1
A*SA 18,1=4000/8
A*SA 19,1=4800/8
A*SA 20,1=5000/8
A*SA 21,1=5800/8
A*SA 22,1=6000/8
A*SA 23,1=6800/8
A*SA 24,1=7000/8
A*SA 25,1=7800/8

A*CA 4000=26,1
A*CA 4800=27,1
A*CA 5000=28,1
A*CA 5800=29,1
A*CA 6000=30,1
A*CA 6800=31,1
A*CA 7000=32,1
A*SA 26,1=4000/8
A*SA 27,1=4800/8
A*SA 28,1=5000/8
A*SA 29,1=5800/8
A*SA 30,1=6000/8
A*SA 31,1=6800/8
A*SA 32,1=7000/8
A*

<RST>
<AD>    FF17
<GO>

(RUBOUT)


OS-65D V3.0
OSI 9 DIGIT BASIC
COPYRIGHT 1977 BY MICROSOFT
 36225 BYTES FREE

OK
```

Table 4. Adapting an OS-65D V3.1 diskette to the Junior Computer (Part 3).

How does the bootstrap routine operate?

Now that we know what the software in the bootstrap EPROM consists of, we should discuss operation of the bootstrap routine. Once you have entered
<RST>
<AD> FF17
<GO>
into the computer, the following operations take place:

1) The computer sets the indirect jump vector for the (BREAK) key on the terminal. The NMI vector points to the hex display monitor.

2) The computer initializes the I/O on the floppy disk interface p.c.b. (6821 and 6850) and the serial I/O for the terminal (6532). When all I/O lines have been initialized the computer waits for the RUBOUT character from the terminal, to measure the baud rate. The baud rate is stored in memory cells $FA5A . . . FA5D (see floppy disk documentation).

3) Once the baut rate of the terminal has been measured, the computer loads track 0 (= 2 K bytes of software in machine language). The steps required to load track 0 into the computer are as follows:

- Position the read/write head of the drive over track 0. A light barrier in the drive informs the computer when the head is positioned over track 0.
- The computer then emits a head load pulse to the drive. The read/write head is lowered onto the surface of the diskette. The computer then waits for the index hole in the diskette. Another light barrier generates the index pulse as soon as the index hole of the diskette passes the light barrier.
- Once the index pulse has decayed, the control register is set in the ACIA (6850). The transfer format of the ACIA is: one start bit, eight data bits, one even parity and one stop bit.
- The computer reads the first byte from the diskette. This byte is the most significant start address of the memory area in which track 0 is stored (= $22). The second byte from the diskette is the least significant byte of the start address (= $00). Both bytes are loaded into the bump pointer (load pointer). Thus the bump pointer points to address $2200. The computer then reads the third byte from the diskette. This byte indicates the number of pages on track 0 (= $08).
- The next bytes are 2 K bytes of software in machine language. These bytes are loaded from the diskette into the computer. The memory area is $2200 . . . 29FF.
- Once track 0 has been stored in the memory, the read/write head is raised from the surface of the diskette and a jump to address $2200 takes place. Starting with this address, the computer finds further instructions concerning the address into which the tracks and sectors are to be loaded. Normally the two K bytes of software on track 1 are loaded into address range

```
RUN"BEXEC*"

BASIC EXECUTIVE FOR
OS-65D V3.1

JUNE 25, 1980 RELEASE

FUNCTIONS AVAILABLE:

  CHANGE- ALTER WORK-
    SPACE LIMITS

  DIR- PRINT DIRECTORY

  UNLOCK- UNLOCK SYSTEM
    FOR END USER MODI-
    FICATIONS

FUNCTION? UNLOCK

SYSTEM OPEN

OK
RUN

BASIC EXECUTIVE FOR
OS-65D V3.1

JUNE 25, 1980 RELEASE

FUNCTIONS AVAILABLE:

  CHANGE- ALTER WORK-
    SPACE LIMITS

  DIR- PRINT DIRECTORY

  UNLOCK- UNLOCK SYSTEM
    FOR END USER MODI-
    FICATIONS

FUNCTION? DIR
LIST ON LINEPRINTER INSTEAD OF DEVICE # 1 ? NO

OS-65D VERSION 3.0
 -- DIRECTORY --

FILE NAME    TRACK RANGE
------------------------
OS65D3       0  - 12
BEXEC*       14 - 14
CHANGE       15 - 16
CREATE       17 - 19
DELETE       20 - 20
DIR          21 - 21
DIRSRT       22 - 22
RANLST       23 - 24
RENAME       25 - 25
SECDIR       26 - 26
SEQLST       27 - 28
TRACE        29 - 29
ZERO         30 - 31
ASAMPL       32 - 32

 50 ENTRIES FREE OUT OF 64


OK
```

Table 5. 'Trial run' of an adapted OS-65D V3.1 diskette. Utility program BEXEC* is called when the BASIC interpreter has been loaded.

$2A00 . . . 31FF. Track 0 and track 1 jointly contain 4 K bytes of software in machine language, which make the entire disk operating system operable.

- Once the disk operating system (DOS) has been loaded into the computer, the BASIC interpreter is loaded from the diskette into the memory. With OS-65D V3.1 the BASIC interpreter is located on tracks 2 . . . 4. With OS-65D V3.3 the BASIC interpreter and various extensions of the editor are located on tracks 2 . . . 4, track 6 and track 13. When the interpreter has been loaded a jump is made to the cold-start entry of the BASIC interpreter ($20E4). The system then responds with the prompt 'OK'.
- The system is not yet ready for the statements LIST, CONT etc.. Even a BASIC file cannot yet be created. The only BASIC statement that the computer recognizes is RUN. If you wish to generate a BASIC file, load the program BEXEC* into the computer using the command:

RUN 'BEXEC*'

The computer then presents a menu of options. With OS-65D V3.1 select the option 'UNLOCK' and with OS-65D V3.3 select option '9'. The computer responds with the prompt 'SYSTEM OPEN'. Now enter a 'NEW' statement and the work space of the Junior is formatted for your BASIC file.

```
OK
LIST

 10 REM DIRECTORY UTILITY FOR OS-65D VERSION 3.0
 20 REM
 30 NF=0
 40 PN=11897
 50 DEF FNA(X)=10*INT(X/16)+X-16*INT(X/16)
BREAK
OK


NEW

OK
RUN"DIR"
LIST ON LINEPRINTER INSTEAD OF DEVICE # 1 ? NO

OS-65D VERSION 3.0
 -- DIRECTORY --

FILE NAME    TRACK RANGE
------------------------
OS65D3       0  - 12
BEXEC*       14 - 14

BREAK IN  11110
OK
CONT
CHANGE       15 - 16
CREATE       17 - 19
DELETE       20 - 20
DIR          21 -
BREAK IN  11100
OK
```

Table 6. Checking the (BREAK) key with the LIST command and the RUN statement.

```
                                              02
                                              03
                                              04
                                              05
                                              06
A*CA 0200=13,1                                07
                                              08
A*GO 0200                                     09
                                              10
                                              11
                                              12
- DISKETTE UTILITIES -                        13
                                              14
SELECT ONE:                                   15
1) COPIER                                     16
2) TRACK 0 READ/WRITE                         17
? 1                                           18
                                              19
                                              20
- DISKETTE COPIER -                           21
                                              22
FROM DRIVE (A/B/C/D)? A                       23
                                              24
TO DRIVE (A/B/C/D)? B                         25
                                              26
                                              27
STARTING TRACK? 2                             28
                                              29
ENDING TRACK (INCLUSIVE)? 32                  30
                                              31
READY (Y/N)? Y                                32
```

Table 7. If two floppy disk drives are available (drive A and drive B), an OS-65D V3.1 diskette can be adapted very easily. Copying is performed automatically by the computer.

The DOS and its capabilities

The Junior Computer can easily be converted to various transient processors with Ohio's disk operating system, which is located on track 0 and track 1 of the diskette. Figure 5 shows how the individual connections between the DOS and the processors can be made and cancelled. If, for example, you start the DOS at address $FF17 the Junior becomes a BASIC computer. If you want to convert the Junior to an Assembler computer, you must enter EXIT in order to leave the BASIC interpreter. After the EXIT command the Junior responds with the DOS prompt A* or B*, etc. on the printer. If you then enter AS or Assembler the Junior converts itself to an Assembler Computer. You can then create an Assembler file and write on the diskette with the DOS. However, you can also assemble the source file and program the object code directly in the EPROM with the ELEKTOR EPROM programmer, without having to type in a single byte. The computer performs this task automatically. For further details regarding operation with Assembler, please consult Ohio Scientific's Assmbler Manual. Note that the Assembler and Extended Monitor are not on the diskette in the case of OS-65D V3.1. Only OS-65D V3.3 has the Assembler and Extended Monitor (EM) on the diskette as standard.

Adapting an OS-65D V3.1 diskette for one drive

If you have only one drive, V3.1 can only be adapted to the Junior Computer with a considerable amount of typing. Tables 2, 3 and 4 show how this is done. First we start the system with the hex keyboard. A program with which a V3.1 diskette can be loaded into the Junior Computer to facilitate modification begins at address $FFE2. When the (RUBOUT) key has been pressed the computer loads track 0 and track 1 into the memory and responds with *TRACK 0&1*. The display lights up, the vectors for the input and output routines are automatically loaded and the programmer can now modify some bytes at addresses $2217, $2245 and $2283. Once the bytes have been modifield in accordance with Table 2, a jump to the DOS command interpreter is made using the <PC> key. The DOS responds with the prompt A*.

The command CA 0200-13,1 loads from track 13, sector 1 of the diskette. The data are stored in the computer from address 0200 onwards. The program that we have just loaded into the Junior Computer is a disk copier and track 0 read/write utility. You can write the modified DOS onto track 0 of your diskette with the track 0 read/write utility program. But first you must initialize your diskette. Remove the Ohio diskette from the drive and insert your diskette, then close the door of the drive. Table 3 shows the next steps: type the word IN. This command initializes the diskette. The system asks: 'ARE YOU SURE? '. Your reply is Y(ES). The drive ceases clicking when the formatting in-

Table 8. Adapting an OS-65D V3.3 diskette. BASIC is loaded via a jump to the DOS command interpreter (GO 2276) and copied with the utility program BEXEC*. Finally a 'trial run' is executed to ensure that the diskette was adapted correctly.

```
<RST>
<AD>    FFE8
<GO>

(RUBOUT)

*TRACK 0&1*

<AD>    2217
<DA>    4C
<+>     40
<+>     22

<AD>    2245
<DA>    4C
<+>     76
<+>     22

<AD>    2285
<DA>    8E
<+>     C6
<+>     2A
<+>     4C
<+>     B3
<+>     22

<AD>    2E84
<DA>    4C
<+>     B0
<+>     2E

<PC>

A*CA 0200=06,4

A*GO 0200

- TRACK ZERO READ/WRITE UTILITY -

COMMANDS:
Rnnnn - READ INTO LOCATION nnnn.
Wnnnn/gggg,p - WRITE FROM nnnn FOR p PAGES
               WITH gggg AS THE LOAD VECTOR
E - EXIT TO OS-65D

COMMAND? W2200/2200,8

- TRACK ZERO READ/WRITE UTILITY -

COMMANDS:
Rnnnn - READ INTO LOCATION nnnn.
Wnnnn/gggg,p - WRITE FROM nnnn FOR p PAGES
               WITH gggg AS THE LOAD VECTOR
E - EXIT TO OS-65D

COMMAND? E

A*SA 01,1=2A00/8

A*

<RST>
<AD>    FF17
<GO>

(RUBOUT)


OS-65D V3.0
OSI 9 DIGIT BASIC
COPYRIGHT 1977 BY MICROSOFT
 34177 BYTES FREE

Ok
RUN"BEXEC*"

OS-65D  Tutorial disk five - Sept. 16, 1981
 1 > Directory
 2 > Create a new file
 3 > Change a file name
 4 > Delete file from diskette
 5 > Create blank data diskette
 6 > Create data diskette with files
 7 > Create buffer space for data files
 8 > Single or dual disk drive copier
 9 > Enter OS-65D system
Type the number of your selection
and depress RETURN ? 1

    Directory utility
Directory of which drive ?
Type A,B,C or D and depress RETURN <A> ?

Do you want to list the directory
to the printer (Yes or No) <No> ?

  -- Directory --
File name    Track range
------------------------
 OS65D3       0  - 13
 BEXEC*      14  - 16
 COPIER      17  - 18
 CHANGE      19  - 20
 CREATE      21  - 22
 DELETE      23  - 23
 DIR         24  - 24
 RANLST      25  - 26
 RENAME      27  - 27
 SECDIR      28  - 28
 SEQLST      29  - 30
 TRACE       31  - 31
 ZERO        32  - 33
 ASAMPL      34  - 34
```

```
 ATNENB      35 - 35
 COLORS      36 - 36
 MODEM       37 - 38
 COMPAR      39 - 39
 46 Entries free out of 64

Depress RETURN to continue ?

<RST>
<AD>    FFE8
<GO>

 (RUBOUT)


*TRACK 0&1*


<PC>


A*GO 2276

OS-65D V3.0
OSI 9 DIGIT BASIC
COPYRIGHT 1977 BY MICROSOFT
 33921 BYTES FREE

Ok
RUN"BEXEC*"

OS-65D  Tutorial disk five - Sept. 16, 1981
 1 > Directory
 2 > Create a new file
 3 > Change a file name
 4 > Delete file from diskette
 5 > Create blank data diskette
 6 > Create data diskette with files
 7 > Create buffer space for data files
 8 > Single or dual disk drive copier
 9 > Enter OS-65D system
Type the number of your selection
and depress RETURN ? 8

- Diskette copier -

Copy from which drive (A/B/C/D) ? A

Copy to which drive (A/B/C/D) ? A

What is the last track to be copied (Inclusive) <0-39> ? 39

Are you ready to start copying (Y/N) ? Y

Insert master diskette -- press <RETURN> ?

Reading --

Insert blank diskette -- press <RETURN> ?

Initializing --

Track 01 - 01/08
Track 02 - 01/08
Track 03 - 01/08
Track 04 - 01/08
Track 05 - 01/08
Track 06 - 01/01 - 02/01 - 03/01 - 04/02
Track 07 - 01/08
Track 08 - 01/08
Track 09 - 01/08
Track 10 - 01/08
Track 11 - 01/01 - 02/01 - 03/01 - 04/01 - 05/01 - 06/01 - 07/01
Track 12 - 01/01 - 02/01 - 03/01 - 04/01
Track 13 - 01/08
Track 14 - 01/08

Insert master diskette -- press <RETURN> ?

Reading --

Insert blank diskette -- press <RETURN> ?

Track 15 - 01/08
Track 16 - 01/08
Track 17 - 01/08
Track 18 - 01/08
Track 19 - 01/08
Track 20 - 01/08
Track 21 - 01/08
Track 22 - 01/08
Track 23 - 01/08
Track 24 - 01/08
Track 25 - 01/08
Track 26 - 01/08
Track 27 - 01/08
Track 28 - 01/08


Insert master diskette -- press <RETURN> ?

Reading --


Insert blank diskette -- press <RETURN> ?


Track 29 - 01/08
Track 30 - 01/08
Track 31 - 01/08
Track 32 - 01/08
Track 33 - 01/08
Track 34 - 01/08
Track 35 - 01/08
Track 36 - 01/08
Track 37 - 01/08
Track 38 - 01/08
Track 39 - 01/05 - 02/02
```

6

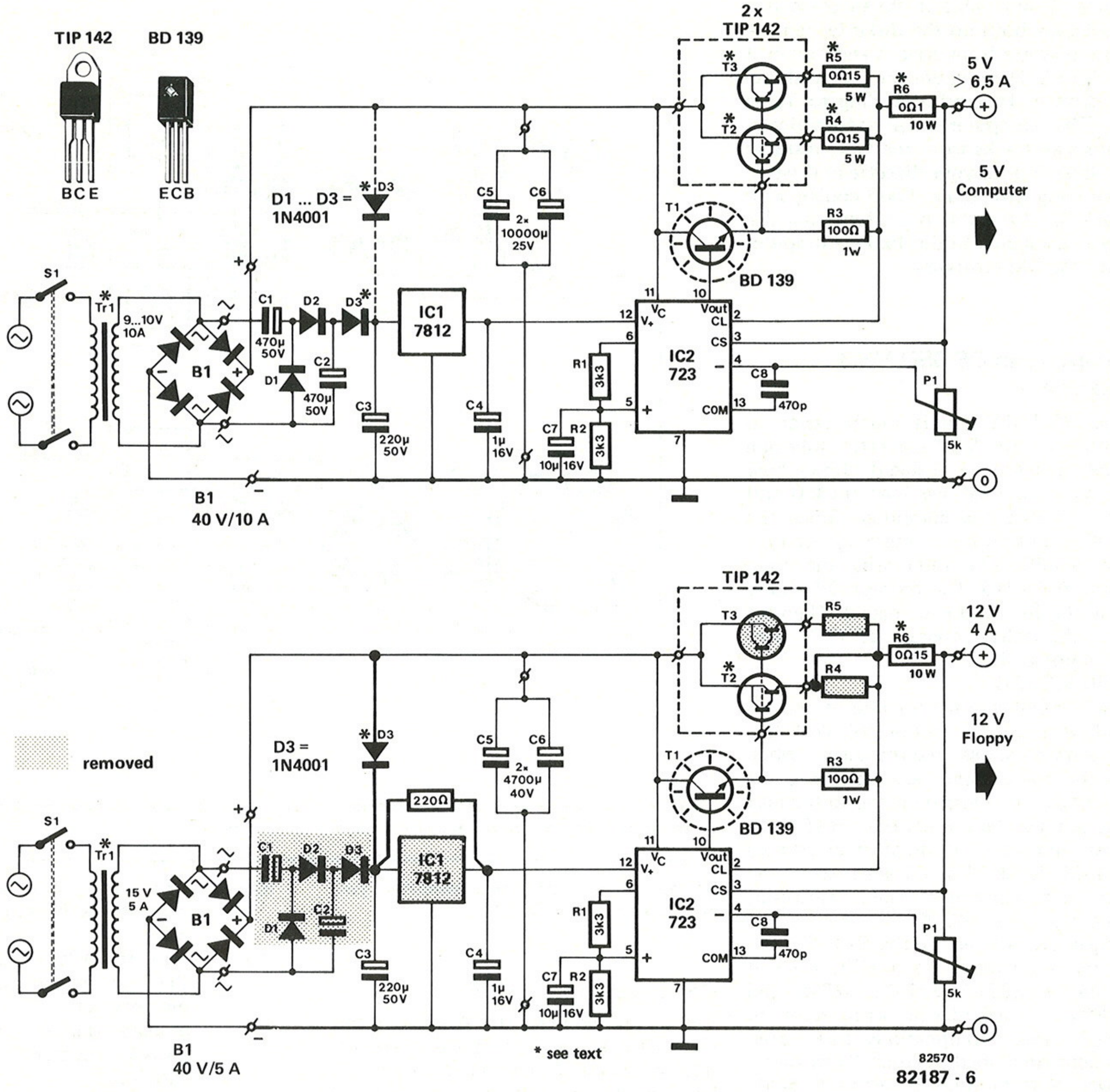


Figure 6. These two hefty power supplies are more than adequate for powering the DOS Junior Computer. They can both be constructed on Elektor printed circuit boards (EPS 82570). They are sufficiently rated to power a complete Junior Computer, including four disk drives.

formation has been written on all 39 tracks of the diskette. After initialization the diskette is ready for read/write operations. Now proceed according to Table 3. First you write eight pages of software on track 0 with the command W2200/2200,8. The start address is $2200 and the load vector for the bootstrap function is also $2200. The first half of the DOS is thus written on the diskette.

The command SA 01,1=2A00/8 saves a data block of a length of eight pages on track 1, sector 1, beginning with start address $2A00. You save the second part of the DOS on the diskette with this command. Since, with the V3.1 copier it is not possible to copy from drive A to drive A, copying must be performed track by track and manually. Table 4 shows how this is done. It should be noted that with the 'CA' commands the Ohio diskette is mounted in drive A, whilst with the 'SA' commands your diskette is mounted in drive A. When tracks 2 . . . 32 have been copied from the Ohio diskette onto your diskette, a trial run can be started. Switch off the supply voltage of the computer. Wait a few seconds and switch the supply voltage on again. Mount your diskette in drive A. Start the bootstrap function at address $FF17 as shown in Table 4. The system responds with a message and the prompt 'OK'. The number of free bytes depends on the capacity of the RAM. With a 48 K byte dynamic RAM you have access to 36225 memory locations.

Start the utility program BEXEC* with the command RUN 'BEXEC*'. This program is written in BASIC. The computer prints a menu of options. First select the option UNLOCK; the computer is now ready for all BASIC statements.

Proceed as shown in Table 5. Start the directory utility program. The computer then prints the entire directory. Finally, a check should be made to establish whether the (BREAK) key of the terminal is functioning correctly. Table 6 shows how a LIST command is first interrupted and a program is then terminated with the (BREAK) key. You can continue the program from its point of interruption using the CONT command.

Adapting an OS-65D V3.1 diskette for two drives

It is considerably easier to adapt V3.1 to the Junior Computer when two drives are connected. Modify and copy track 0 and track 1 in accordance with Table 2 and Table 3. When these two tracks are both on the diskette, remove your diskette from drive A and mount it in drive B. Now mount the Ohio diskette in drive A. Proceed according to Table 7. The computer now automatically copies all tracks from the Ohio diskette in drive A onto your diskette in drive B, beginning with track 2 and ending with track 32. After this procedure your diskette is adapted to the Junior Computer with the Ohio software.

7

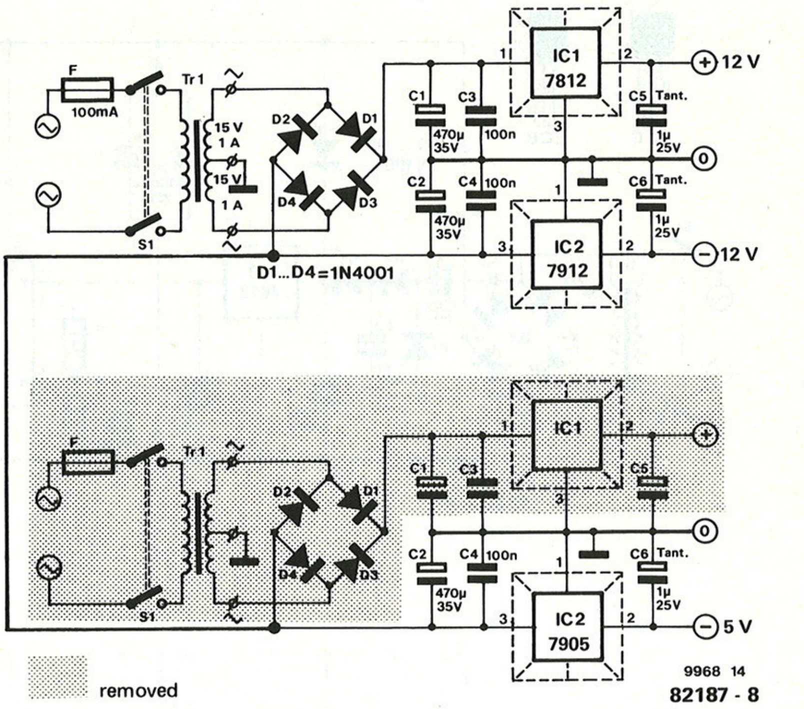


Figure 7. The power supplies for the dynamic RAMs and the printer interface can also be built quite simply with Elektor printed circuit boards (EPS 9968-5a).

Adapting an OS-65D V3.3 diskette

The V3.3 diskette is much easier to adapt than the V3.1 diskette. Only one drive is required. Table 8 shows how to proceed. First we load track 0 and track 1 into the computer. Since the DOS is located in the memory, we load the BASIC interpreter with the command GO 2276. The prompt OK shows that the interpreter is loaded. Then we load the utility program BEXEC* with the command:

RUN 'BEXEC*'

The computer prints a menu of options and we select the option '8'. With this option we are selecting the copier. When all the tracks have been copied, some modifications must be made to the disk operating system. Press the <RST> key again and start the program at address $FFE8. Tracks 0 and 1 are then loaded into the computer again. However, memory area $2200 . . . 22FF is no longer overwritten by the BASIC interpreter. Implement the modifications at addresses $2217, $2245, $2285 and $2E84 in accordance with table 8. Once these modifications have been implemented, load the track 0 read/write program from track 6, sector 4. Write the modified DOS onto track 0 of the diskette again using this program. The command SA 01,1=2A00/8 saves eight pages of DOS software on track 1. You now have a V3.3 diskette which is adapted to the Junior Computer. You can start BASIC at address $FF17. The DOS and BASIC interpreter are automatically loaded into the Junior Computer after you have pressed the (RUBOUT) key — see Table 8.

The DOS command interpreter

As already mentioned, the disk operating system has its own command interpreter. We shall now examine the most important commands. If a command is not entered correctly an error message is issued.

Whenever the computer has printed the DOS prompt A* or B* you can enter a DOS command after the prompt. The computer only recognizes the first two upper-case letters of each command. With a SAVE command, for example, it makes no difference whether you enter SA, SAV or SAVE.

Command AS or ASM

The computer loads the Assembler and Extended Monitor from the currently selected drive. Once this program has been loaded in machine language, a jump is made to the cold-start entry of the Assembler. The Assembler is linked with a line-oriented editor.

Command EM

The computer loads the Assembler and Extended Monitor from the currently selected drive. Once this program has been loaded in machine language, a jump is made to the Extended Monitor. This is a program with which a machine language program can easily be checked. The Extended Monitor has its own command interpreter. The most important commands are:

!STRING

Send 'STRING' to the DOS command interpreter as a command.

aNNNN

Open the memory cell with the address NNNN for execution of the following subcommands:

(LF)	open the next memory cell
(CR)	close the currently addressed memory cell
(D)(D)	write the data into the currentlt addressed memory cell
('')	print the ASCII character of the currently addressed memory cell
(/)	prepare the currently addressed memory cell for data input
(^)	open the previously addressed memory cell for data input

BN,LLLL

Set the break point with number N at address LLLL. The numeric range of the break point number N is 1 . . . 8.

EN

Eliminate the break point with number N.

A

Print the accumulator contents resulting from the last break point.

C

Start the program after the last break point.

DNNNN,MMMM

Make a memory dump from address NNNN up to and excluding address MMMM.

EX

Leave the Extended Monitor and return to DOS.

FNNNN,MMMM=DD

Fill the memory area beginning with address MMMM and ending with address MMMM−1 with the data DD.

GNNNN
Jump to address NNNN and process the program there.

HNNNN,MMMM(OP)
Call of the hexadecimal arithmetic unit. The arithmetic unit prints the result NNNN (OP) MMMM, where (OP) can be equal to +, –, *, /. Addition, subtraction, multiplication and division of hexadecimal numbers can be executed.

MNNNN=MMMM,LLLL
Move memory area MMMM . . . NNNN–1 into the memory area that begins at address NNNN.

RMMMM=NNNN,LLLL
The Extended Monitor has a so-called relocator. This allows machine language programs to be moved to another memory area. The computer performs the correcting of all absolute addresses: 'Relocate' the memory area between NNNN . . . LLLL–1 into the memory area that begins at address MMMM.

The Extended Monitor has some other commands which you can find in the Ohio Manual.

Command BA

The command loads the BASIC interpreter from the currently selected drive. Once the BASIC interpreter has been loaded, a jump is made to the cold-start entry. The interpreter provides information regarding the number of free memory locations in the system and responds with the prompt 'OK'.

Command CA NNNN=TT,S or CALL NNN= TT,S

Load the data from track TT, sector S of the diskette into the computer. Store the data in memory area NNNN . . . The numeric range for TT is 1 . . . 39 and the numeric range for S is 1 . . . 8.

Command SA TT,S=NNNN/8PP or SAVE TT,S=NNNN/P

Save the data in memory area NNNN . . . for P pages onto the diskette. The track number is TT, the sector number is S and the number of pages to be written onto the diskette is P. The numeric range for TT is 01 . . . 39, for S it is 1 . . . 8 and for P it is also 1 . . . 8.

Command DI TT or DIR TT

This command allows a check of the numbers of sectors on track TT to be made. The numeric range of TT is 01 . . . 39.

Command IN or INIT

The command IN initializes a new diskette on which no data have been written yet. If you wish to erase a recorded diskette, you can do so with the IN command.

Command IN TT:

This initializes track TT only.

8

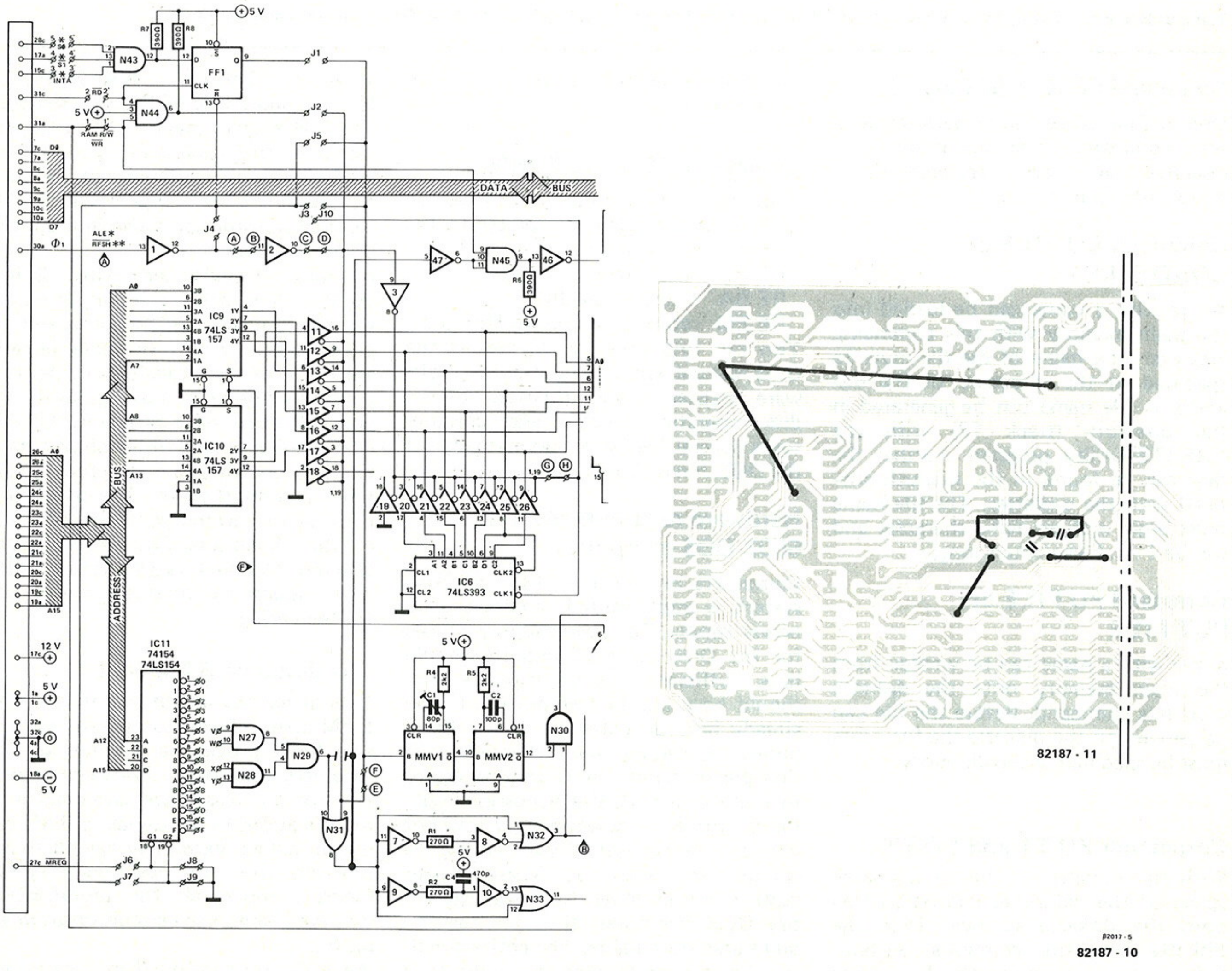


Figure 8. These modifications contribute greatly to the proper functioning of the dynamic RAM card.

```
       0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F

FC00: A9 1E 8D 83 FA A9 01 85 FD A2 FF 9A 78 D8 20 7C
FC10: FC D0 FB 20 7C FC F0 FB 20 7C FC F0 F6 20 E1 FC
FC20: C9 13 D0 07 A2 FF 9A D8 6C FA 00 C9 10 D0 06 A9
FC30: 01 85 FD D0 14 C9 11 D0 06 A9 00 85 FD F0 0A C9
FC40: 12 D0 09 E6 FA D0 02 E6 FB 4C 0D FC C9 14 D0 C3
FC50: 4C FD FE C9 15 10 F2 85 FF A4 FD D0 0D B1 FA CA
FC60: 0A 0A 0A 05 FF 91 FA 4C 49 FC A2 04 06 FA 26 FB
FC70: CA D0 F9 A5 FA 05 FF 85 FA 4C 49 FC A0 00 B1 FA
FC80: 85 F9 A9 7F 8D 81 FA A2 08 A5 FB 20 B8 FC A5 FA
FC90: 20 B8 FC A5 F9 20 B8 FC A9 00 8D 81 FA A0 03 A2
FCA0: 00 A9 FF 8E 82 FA E8 E8 2D 80 FA 88 D0 F5 A0 06
FCB0: 8C 82 FA 09 80 49 FF 60 48 84 FC 4A 4A 4A 4A 20
FCC0: CB FC 68 29 0F 20 CB FC A4 FC 60 A8 B9 08 FD 8D
FCD0: 80 FA 8E 82 FA A0 FF 88 D0 FD 88 8C 82 FA E8 E8
FCE0: 60 A2 21 A0 01 20 A1 FC D0 07 E0 27 D0 F5 A9 15
FCF0: 60 A0 FF 0A B0 03 C8 10 FA 8A 29 0F 4A AA 98 10
FD00: 03 18 69 07 CA D0 FA 60 40 79 24 30 19 12 02 78
FD10: 00 10 08 03 46 21 06 0E 20 1E FD 6C FD 00 20 28
FD20: FD 20 CF FD 20 4F FD 60 A0 00 8C 01 C0 A9 40 8D
FD30: 00 C0 A9 04 8D 01 C0 A9 40 8D 00 C0 A2 04 8E 01
FD40: C0 8C 03 C0 88 8C 02 C0 8E 03 C0 8C 02 C0 60 A9
FD50: FB D0 09 A9 02 2C 00 C0 F0 1C A9 FF 8D 02 C0 20
FD60: CE FD 29 F7 8D 02 C0 20 CE FD 09 08 8D 02 C0 A2
FD70: 18 20 BA FD F0 DD A2 7F 8E 02 C0 20 D7 FC AD 00
FD80: C0 30 FB AD 00 C0 10 FB A9 03 8D 10 C0 A9 58 8D
FD90: 10 C0 20 C5 FD 85 FE AA 20 C5 FD 85 FD 20 C5 FD
FDA0: 85 FF A0 00 20 C5 FD 91 FD C8 D0 F8 E6 FE C6 FF
FDB0: D0 F2 86 FE A9 FF 8D 02 C0 60 A0 F8 88 D0 FD 55
FDC0: FF CA D0 F6 60 AD 10 C0 4A 90 FA AD 11 C0 60 D8
FDD0: 78 A9 67 8D 82 FA A9 00 8D 80 FA A2 FC 8E 5A FA
FDE0: A2 FF 8E 5B FA EA A9 7F 8D 81 FA 4A 8D 83 FA A2
```

```
FDF0: 03 8E 59 FA 2C 80 FA 30 FB 20 4F FE 4E 5F FA 6E
FE00: 5E FA AD 5E FA 8D 5C FA AD 5F FA 8D 5D FA A2 08
FE10: 20 72 FE 20 2B FE C9 7F D0 B5 60 2C 80 FA 30 FB
FE20: 8E 61 FA A2 08 20 72 FE 20 81 FE 2C 80 FA 10 09
FE30: 38 6E 62 FA CA D0 F1 F0 07 18 6E 62 FA CA D0 E8
FE40: 20 81 FE AD 62 FA 29 7F 8D 63 23 AE 61 FA 60 18
FE50: AD 5A FA 69 01 8D 5A FA AD 5B FA 69 00 8D 5B FA
FE60: 2C 80 FA 10 EA AD 5A FA 8D 5E FA AD 5B FA 8D 5F
FE70: FA 60 AD 5C FA 8D 5E FA AD 5D FA 8D 5F FA 38 B0
FE80: 0C AD 5A FA 8D 5E FA AD 5B FA 8D 5F FA 38 AD 5E
FE90: FA E9 01 8D 5E FA AD 5F FA E9 00 8D 5F FA EA EA
FEA0: B0 EB 60 8E 60 FA 8D 62 FA AD 82 FA 29 40 D0 F9
FEB0: AD 82 FA 29 FE 8D 82 FA 20 81 FE A2 07 4E 62 FA
FEC0: 90 30 AD 82 FA 09 01 8D 82 FA 20 81 FE CA D0 ED
FED0: AE 59 FA AD 82 FA 09 01 8D 82 FA 20 81 FE CA D0
FEE0: F2 2C 80 FA 10 04 AE 60 FA 60 2C 80 FA 10 FB 6C
FEF0: 7C FA AD 82 FA 29 FE 8D 82 FA 18 90 CD 20 03 FF
FF00: 4C 51 2A A9 27 8D 82 FA A9 00 8D 80 FA A9 7F 8D
FF10: 81 FA 4A 8D 83 FA 60 A9 2E 8D 7C FA A9 FF 8D 7D
FF20: FA A9 00 8D 7A FA A9 FC 8D 7B FA 4C 18 FD A9 03
FF30: 8D 25 23 60 A9 51 8D 7C FA A9 2A 8D 7D FA A9 00
FF40: 8D 7A FA A9 FC 8D 7B FA 4C 18 FD 6C 7A FA 6C 7E
FF50: FA 20 1E FD A9 28 8D A3 26 A9 01 8D 5E 26 20 BC
FF60: 26 A9 2A 85 FF 20 54 27 86 FE 20 67 29 A9 01 8D
FF70: 21 23 8D 22 23 8D C6 2A 20 C6 29 A9 1A 8D 01 23
FF80: 8D 03 23 A9 A2 8D 11 23 8D 13 23 A9 FE 8D 02 23
FF90: 8D 04 23 8D 12 23 8D 14 23 60 EE 5E 26 A9 06 20
FFA0: BC 26 20 67 29 EE 5E 26 A9 00 85 FE 85 FF 20 67
FFB0: 29 A9 01 8D 5E 26 A9 13 20 BC 26 A9 32 85 FF A9
FFC0: 74 85 FE 20 54 27 20 67 29 20 61 27 20 73 2D 0D
FFD0: 0A 2A 54 52 41 43 4B 20 30 26 31 2A 0D 0A 00 4C
FFE0: 00 FC 20 51 FF 4C C9 FF 20 51 FF 4C 9A FF FF FF
FFF0: FF FF 51 FF FF FF FF FF FF FF 4B FF 00 FC 4E FF
```

Table 9. Hex dump listing for the bootstrap EPROM ESS515. The source listing is available as part of the documentation.

Command SE X or SELECT X

One of four drives can be selected with this command. The computer only operates with one selected drive. X = A, AB, C or D.

Command LO FILE or LOAD FILE

A file with a name can be loaded into the main memory with this command. However, the name of the file must be specified in the directory of the diskette. A file name can be generated in the directory (track 12) with the CREATE utility program. Further details can be found in the manuals supplied with the diskettes. The file name must begin with an alpha character and can be 1 . . . 6 characters long.

Command PU FILE or PUT FILE

A file with a name can be written from the main memory onto the diskette with this command. Before the file can be written on the diskette the file name must be specified in the directory.

Commands PU TT and LO TT

With this command a file in the work space of the computer can be written onto the diskette or read from the diskette into the computer without a file name. However, the file in the work space must not be longer than 2 K bytes. It is advisable not to use these two commands because it is easy to overwrite existing software on the diskette without being warned by an error message.

Command RE or RETURN

With RETURN commands you can return from the DOS interpreter to the present transient processor:

RE AS return to Assembler
RE BA return to BASIC
RE EM return to Extended Monitor

You can find other commands in the Ohio Manual. We shall now end the software adaptation and discussion of the disk operating system and consider some special hardware requirements of the DOS Junior Computer.

Hardware requirements of a 6502 DOS computer

Computers on which a disk operating system is implemented require a good power supply. The power supply chosen for the DOS Junior Computer should have sufficient reserve capacity and should have a pulse-free output. If you already have an extended Junior Computer, you can continue to use the existing power supply. It is only necessary to build a new 12 V/4 A power supply for the drive. If, however, you have not yet got a power supply you can use the circuits in figure 7. These power supplies are intended to power the entire DOS computer; they are easy to build and are reliable. The entire circuit can be accommodated on only four ELEKTOR printed circuit boards:, 2-times ESS 82570 and 2-times ESS 9968-5a. Two transformers are required with the following ratings: 9 . . . 10 V/10 A and 15 V/4.4 . . . 5 A. Both transformers should be of the toroidal type. Toroidal transformers are more expensive than the laminated type but are lighter and generate less of an interference field. The temperature rise of a toroidal transformer is also limited, even under full load.

A third transformer with 2-times 15 V/ 1 A provides the supply voltage for the dynamic RAM cards and the printer interface. No particular demands are made of this transformer. With the power supply circuits of figures 6 and 7 you will never have problems with the DOS Junior or any other 6502 computer, because they are generously overrated and short-proof. The power supplies can be accommodated in a flat case of the dimensions 300 mm x 70 mm x 200 mm. Conductors with a cross-section of 1.5 square millimetres should be used for the wiring.

The dynamic RAM card

Experience has shown that the dynamic RAM card 'refuses' to operate with certain 6502 processors. Neither was the card very fond of the 6809 processor so far. For this reason we have made a few modifications to the dynamic RAM card which make it extremely reliable in conjunction with any 6502/6809 system. Figure 8 shows all the modifications that we made to the circuit diagram and p.c.b..

We wish you continued enjoyment with the DOS Junior Computer which is still the lowest-cost and favourite computer for home construction, with a disk operating system.

a dozen and one sounds...

an assorted box of sound effects

The circuit will be of great interest to experimentors musicians and recording enthusiasts alike. A single chip with a few surrounding components realises a circuit which makes a respectable job of reproducing sounds like, rain, explosions, cars crashing and so on. Ideal for mixing new film sound tracks.

No matter how unusual or irrelevant a sound may be, a use is always found for it and the number of people wanting to produce sound effects is simply amazing. To a certain extent noises of one kind or another are part of everyday life. In artificial environments such as recording studios, discos, concert halls and quiet front rooms the lack of birds chirping and explosions is noticeable. The only way to introduce well known and seemingly well loved (?) noises is to produce them synthetically. This is where the SN76477 IC comes into its own, because it contains all the ingredients of a BBC effects laboratory, producing a large number of refreshing sounds. This Texas IC is not new especially to Elektor readers. The main advantage of using a well proved component is that it is available at a relatively low price.

The IC

The article is aimed at the practical aspects and not at the theory so we will stick to a brief survey of the most important features. The internal layout of the complex sound generator is given in figure 1. A closer look shows that there are three fundamental signals produced. These are obtained from: the super low frequency oscillator (SLF), the voltage controlled oscillator (VCO) and the noise generator.

The SLF provides two output signals: a square-wave processed by the mixer stage and a triangular wave form used to control the VCO by way of the external VCO/SLF select section.

The oscillator frequencies of each stage are determined by the various external RC networks. It is clear from just a rudimentary description that the SN 76477 is a very versatile IC.

The circuit

Because of the enormous capabilities of the IC, to create an endless repertoire is theoretically possible. But, for practical reasons a circuit able to produce a dozen or more different sounds is by far a better investment and a good basis for further experimentation.

Figure 2 shows the complete circuit in block diagram form. The potentiometers set the frequency of each stage. The VCO consists of an oscillator which is dependant on the input voltage. This control voltage can either be the SLF output signal or an externally applied one.

1

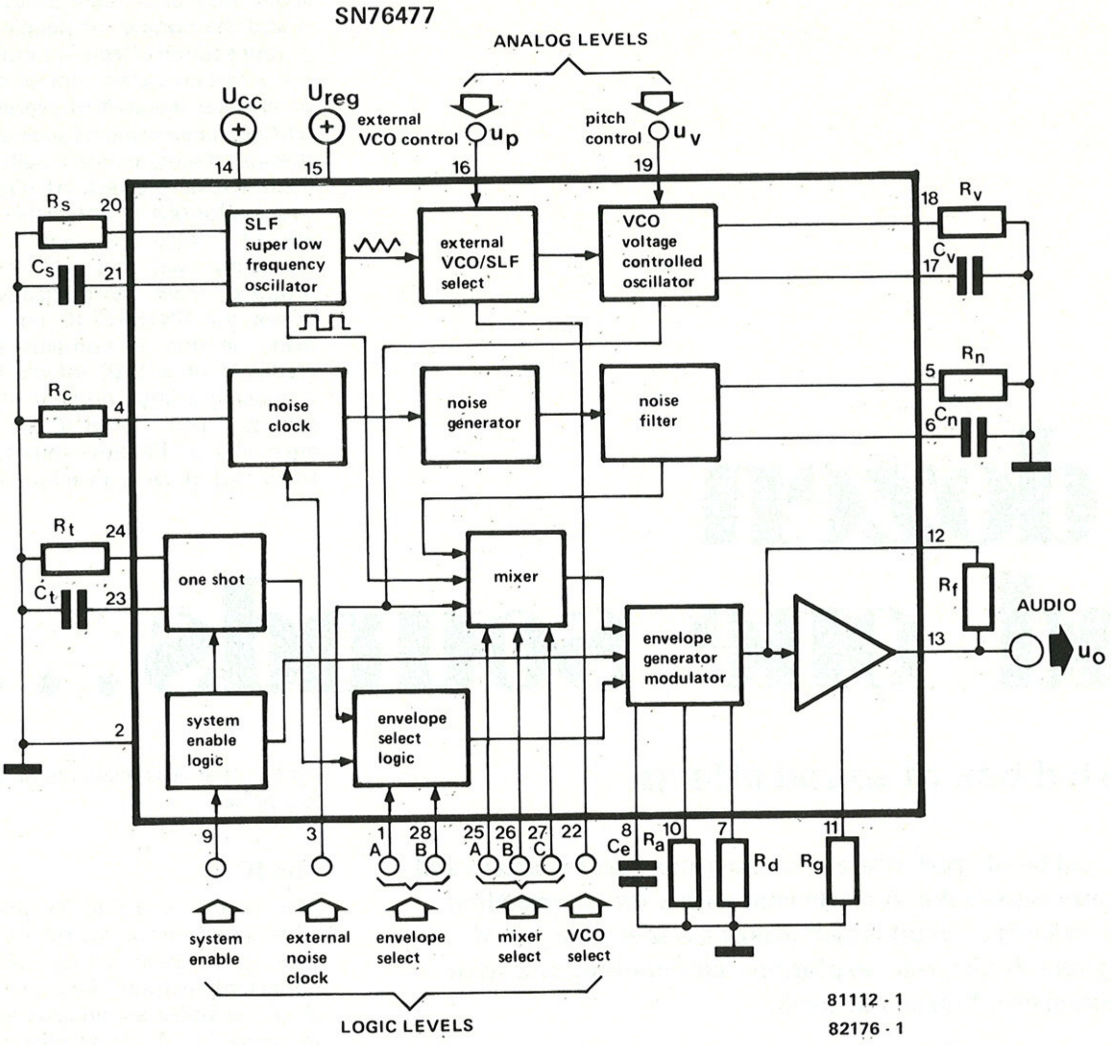


Figure 1. The block diagram of the internal components of the complex sound generator IC. It basically contains an SLF oscillator, a VCO and a random white noise generator.

2

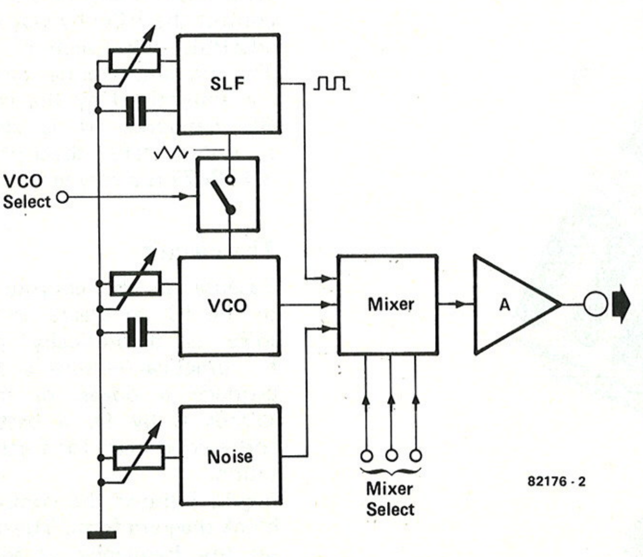


Figure 2. The complete circuit of the effects box in block diagram form.

The output signals from the three stages are fed to the mixer. Depending on the logic levels presented to the mixer select inputs, one, or a combination of the three is passed on.

Figure 3 illustrates the practical circuit design of the effects box. Apart from the complex sound generator IC nearly all the other components are just potentiometers and switches. Transistors T1 and T2 constitute a simple complementary pair AF amplifier with P4 as the volume control.

Because of the number of switches and potentiometers the easiest way to explain their function is to list them.

- P1 adjusts the clock frequency of the pseudo-random white noise generator.
- P3 sets the SLF oscillator frequency.
- S1 determines whether the VCO is controlled by the SLF signal (position 2) or not (position 1).
- S2 is used to switch from one SLF frequency range to another, (1 = high, 2 = low).
- S3, S4, S5 are connected to the select inputs of the mixer stage.
- P2 determines the VCO frequency.

3

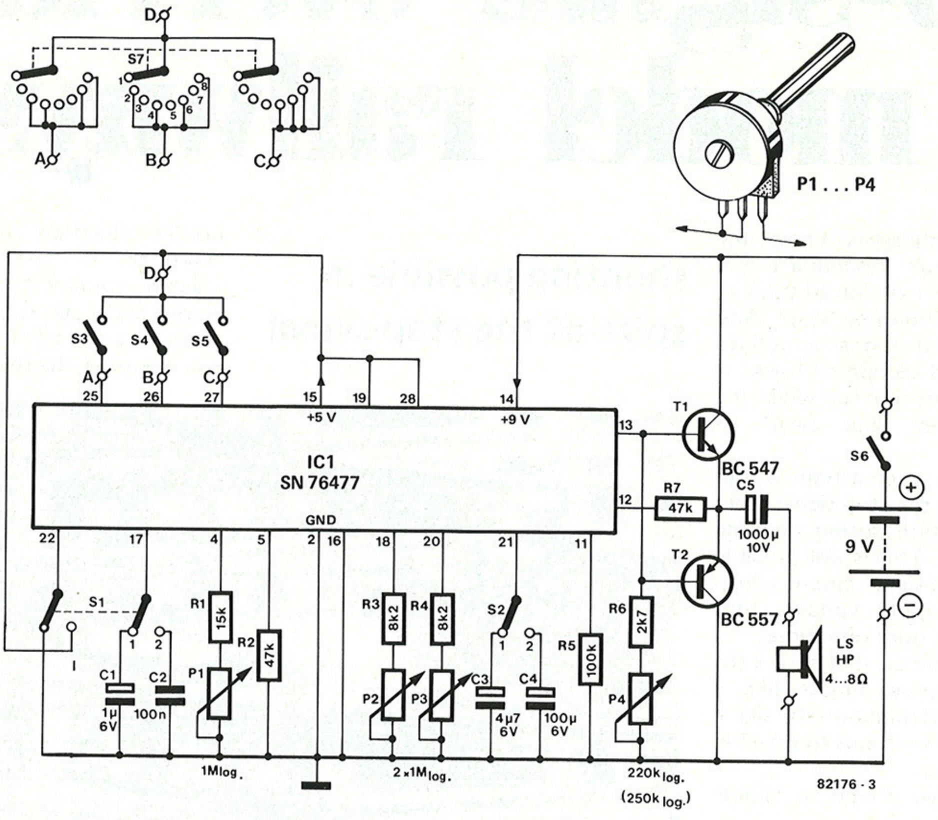


Figure 3. The circuit diagram of the effects box. S3, S4, S5 can be combined into one 8 way switch.

4

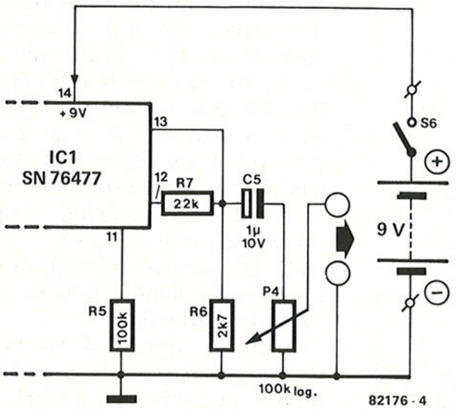


Figure 4. A suitable circuit providing a line feed to your hifi system.

Table 1

closed switches	position of S7	mixer output
—	1	VCO
S4	2	SLF
S3	3	noise
S3, S4	4	VCO/noise
S5	5	SLF/noise
S4, S5	6	SLF/VCO/noise
S3, S5	7	SLF/VCO
S3, S4, S5	8	inhibit

Table 1. The effect produced by each position of S7.

S3, S4, and S5 can be individual switches or combined into one 8 way 3 pole wafer (S7) as shown in figure 3. Table 1 itemises exactly what effect each position of S7 has.

Each new sound produced can be further modified by rotating any one or all of the potentiometers. Constructors wanting to experiment further can try new values for R3, R4 and R6.

Construction

With the accent on experimentation to produce a ready-made printed circuit board would be inappropriate, and anyway, as most of the components are switches and potentiometers it would be a waste of money. In fact vero board or something similar is ideal here.

Any 4 to 8Ω speaker is suitable provided it can handle at least 100 mW. Substituting the amplification stage (T1, T2) with the circuit shown in figure 4 provides a line feed to any Hi Fi system or external power amplifier.

A single 9 V battery is sufficient. This is because the IC contains its own internal voltage regulator (not shown in figure 1) which derives a stable 5 V from the original input voltage (pin 14 9 V in, pin 15 5 V out)). The current consumption will depend on the output volume but it should not exceed 50 mA.

stop-signal override for model railways

shunting possible in spite of the stop-signal

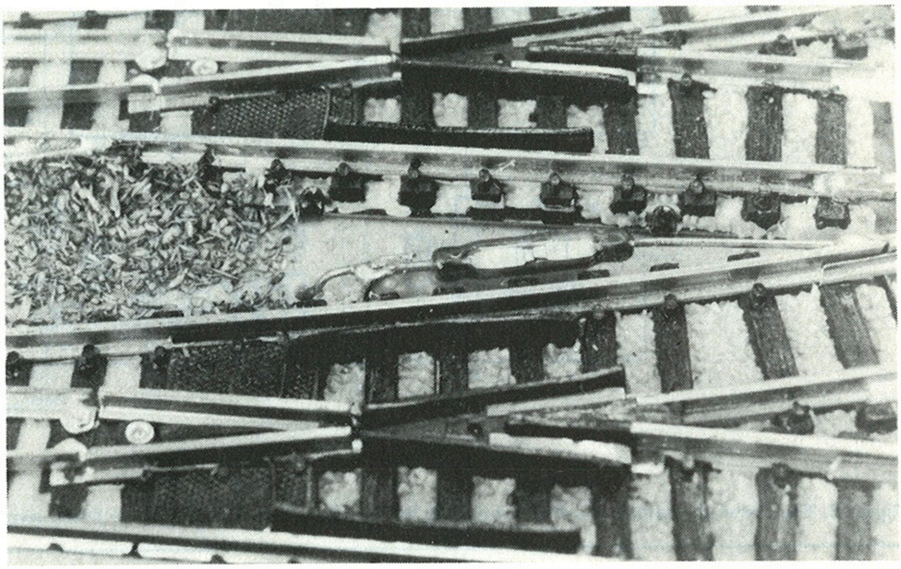
Model railway enthusiasts know the problem: stop-signals disconnect the supply voltage from a section of track as soon as the signal indicates 'stop'. Any train approaching the signal is obliged to stop on the dead section of track. It can only continue its journey when the stop-signal indicates 'line clear' or 'reduce speed'.

The problem arises when a train is supposed to approach the stop-signal from the opposite direction during shunting or at rural stations. This is not possible with the usual stop-signal circuit which disconnects the supply voltage, thus preventing traffic in both directions.

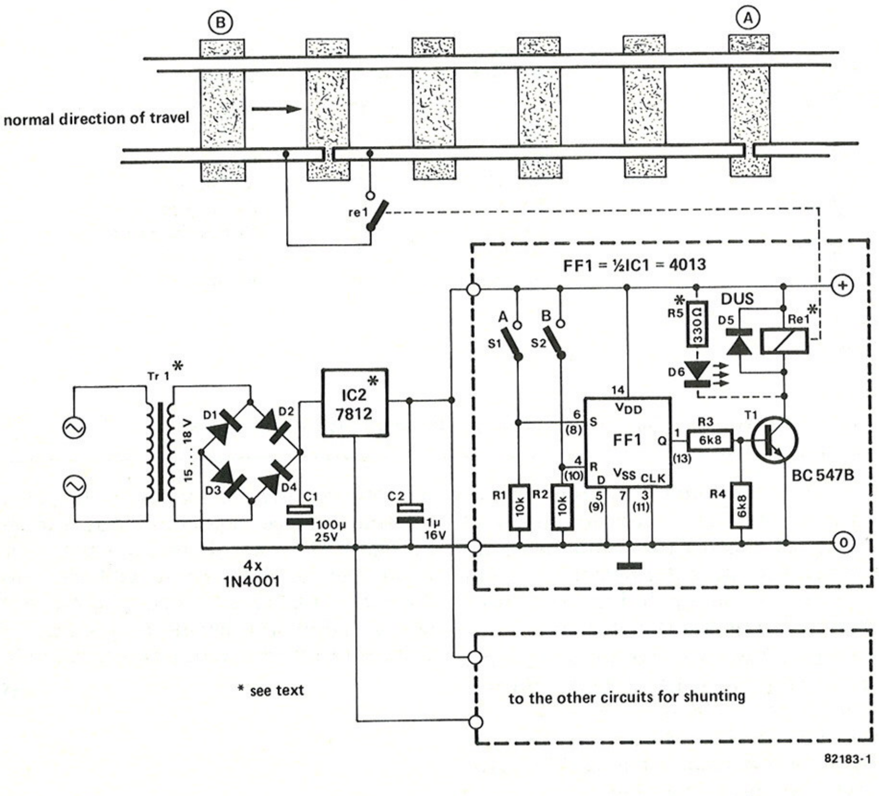
What we need is a circuit that allows the stop-signal to operate almost like a diode: in the normal direction the signal stops trains but allows trains to travel in the reverse direction.

As usual, we have found a simple solution.

In addition to the stop-signal we need two rail contacts at the two ends of the controlled section (see figure 1). These are contact A at the end and contact B at the beginning, when viewed in the normal direction of travel. The train travelling in the reverse direction reaches contact A first. The contact closes and sets flip-flop IC1. The Q-output of the flip-flop goes to logic '1' and energizes the relay via T1. The relay contact closes and bridges the circuit that was originally disconnected by the stop-signal. The train can travel in reverse along the controlled section of track. As soon as it reaches contact B the flip-flop is reset and the original state is restored. A train travelling in the normal direction first reaches contact B, thus causing the flip-flop to be reset and enabling proper functioning of the stop-signal.



1



LED D6 (drawn with dashed lines in the circuit) lights up when the signal override is effective.

The power supply of the override circuit is generously rated and can power several override circuits of this type. The current drawn by one of these circuits depends on the relay used. Transistor T1 can supply a maximum relay coil current of 100 mA.

Instead of using a separate transformer for the power supply, the AC voltage can also be obtained from the 'lighting output' of the model railway transformer.

If a 12 V relay is utilized the AC voltage required is 15 . . . 18 V and a 7812 voltage regulator is needed for IC2. With a 5 V relay a type 7805 regulator must be used for IC2, in which case the transformer secondary voltage should be approximately 8 . . . 12 V. With a relay voltage of 5 V, the value of R5 should be 120 Ω. ◀

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WANTED 7 and 3.5 Mcs crystals CW ends also holders FT243 type or WHU. J.W. Mackay, 11 Lansdowne Grove, Whitehaven.

ELEKTOR JUNIOR computer built and working but not in case. £ 60 O.N.O. Tel. 52998 Basingstoke, K.W. Pearson.

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PAST ISSUES OF ELEKTOR Electronics today intnl. in one complete lot. 0632 525791 between 6 p.m. and 8 p.m.

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Tel. 0706 50223.

MINI MIXER for sale. High quality, special design. Electronics according to Elektor, with some adds. Price £ 80.
Urosevic Predrag, Palmira Toljatija 24/19, 11070 H. Beograd, Yugoslavia.

HYBRID G.E.C. P4E EMO CTVS & panels. Cheap to clear or exchange for frequency meter. GDO or other test gear. Tel. 0742 311191

BC221 WWII frequency meter with calibration cards complete. Also Valves 6CH6, 6AK5, 6F33 what offers. Tel. Romford 41118.

CASIO FX-602P programmable calculator 512 steps/88 memories. 3 months old new £ 75, yours for £ 60. Phone after 7 p.m. Jeffrey, Tel: 01-458-3025.

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Paolo Bozzola, via A. Molinari 20, 25124 Brescia, Italy.

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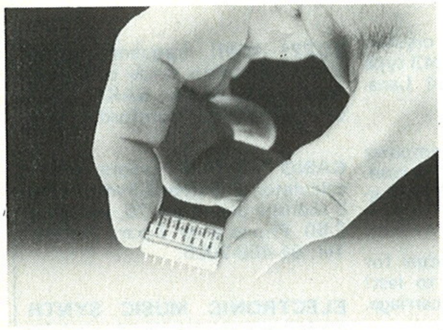
elektor switchboard December

market

Sealed switch

EECO have introduced the environmentally sealed MINI-DIP switch. This model features a flexible, clear cover and an epoxy bottom seal. The switch can be actuated directly through the flexible cover. This configuration offers a maximum protection during the wave soldering and cleaning processes, as well as when used in hostile environmental conditions. The seal will maintain its integrity when subjected to a range of temperature and solvents.



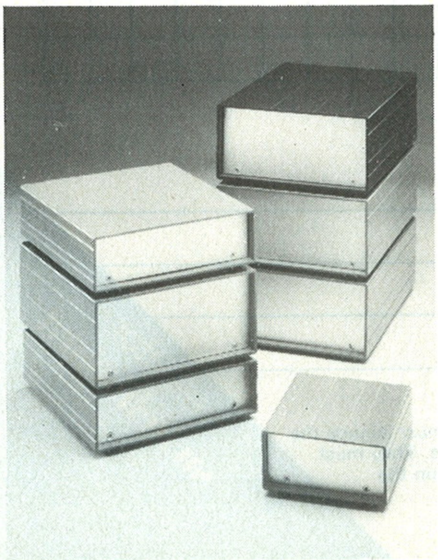
The 2400 series MINI-DIP offers standard gold-on-gold true wiping action contacts and strong .508 mm x .355 mm terminals to virtually eliminate insertion and alignment problems. Standard 2.54 mm x 7.62 mm centres make MINI-DIP compatible with other major brands.

EECO Sales,
Telephone: 0954.8025

(2477 M)

Small instrument enclosures

The K-series of instrument housings is now available from Alusett UK Limited, based in Winchester, Hampshire. These enclosures comprise front and rear satin anodised panels that attach to a tubular blue powder-dipped aluminium cover using brass fixing bushes.



Six sizes, from 90 x 42 x 100 mm to 138 x 66 x 200 mm, are available and separate chassis are offered which can be secured to the front and rear panels using 3.5 mm screws. Special sizes, configurations and colours, can be supplied by Alusett to suit non-standard requirements.

Alusett UK Ltd.,
Whiteshute Lane,
Winchester
Telephone: 0962.68673

(2509 M)

Alphanumeric keypads

A range of cost-effective keypads, formed from Shin-etsu conductive silicon rubber is now available from N.S.F.

Advantages of this range include . . .

- extended operational life
- reduced assembly costs
- one-piece construction
- elimination of spring and plunger assembly
- low chatter and bounce
- impervious to many contaminants
- non-discolouration of pads

Most conventional keyboards for computer data entry incorporate metal contacts and mechanical actuation. Dirt, dust and other contaminants will, of course, render this type of construction liable to failure should they get between the contacts. Also, economically, such keyboards tend to be costly due to the use of gold plated contacts and to a more labour intensive manufacturing and assembly system.

In comparison, the new keyboards are formed with conductive rubber instead of metal for the key contacts and silicon rubber domed membranes instead of mechanical switches.

N.S.F. Limited,
Switches and controls,
Keighley,
West Yorkshire BD21 5EF
Telephone: 0535.61144

(2508 M)

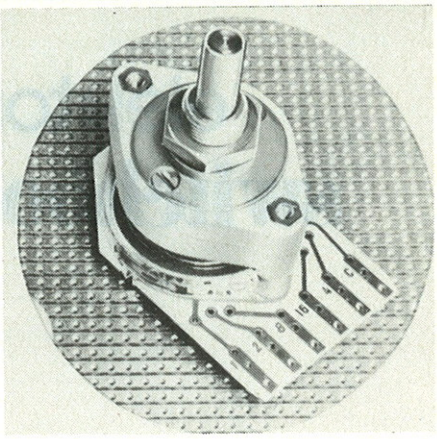
BCD switches

The model CBS switches from N.S.F. are available in both binary and binary coded complement outputs. They are provided with various terminations including pcb and wirewrap. The moulded indexing mechanism is fully enclosed giving effective protection for the rotor connections to the printed circuit tracks. Four indexing configurations are available:

12 positions at 30°
16 positions at 22.5°
24 positions at 15°
32 positions at 11.25°

Stops can be fitted as specified or made adjustable for customer adjustment.

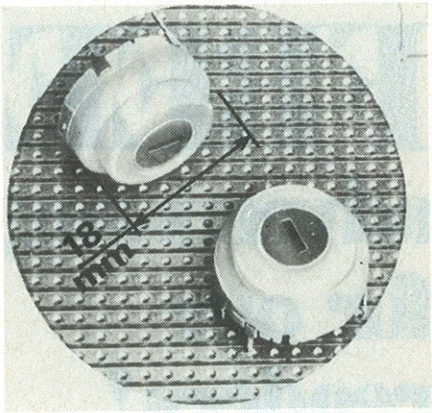
The model CBS switch has a switching capacity of 3 VA with a resistive load, switches a maximum current of 100 mA, a voltage of 60 V rms and has an insulation resistance of not less than 50,000 megohms.



N.S.F. Limited,
Keighley,
Yorkshire BD21 5EF
Telephone: 0535.61144

Subminiature binary coded wafer switch

The CLSA from NSF is a small, moulded, binary coded, single wafer, rotary switch for pcb mounting. The compact and low profile of this switch, manufactured to the EBE system, accommodates both the index mechanism and the switching contacts in a single moulding, 18.6 mm dia. and only 10 mm deep, and also has the position numbers moulded into the face.



Model CLSA has a switching capacity of 3 VA max. with a resistive load, carries 1 A and has an insulation resistance of 10,000 megohms. Contacts incorporate a gold flashed finish.

N.S.F. Limited,
Keighly,
Yorkshire,
BD21, 5EF.
Telephone: 0535.61144

(2480 M)

market

market

Voice response unit

The VR8 Voice Response Unit provides clear, human speech output from existing computers over the dialled telephone network. The VR8 automatically accepts incoming calls from telephones with multi-frequency tones or standard telephones with pocket sized 'Minitone' keypad attached, and passes the data to a computer in the normal manner. The speech facility is activated by commands from a computer and the Unit's own microcomputer then delivers speech down the telephone line.

Although the system is expected to operate mainly over the telephone, the unit may also be used to provide speech in conjunction with or as an alternative to computer output, normally associated with Video displays, where speech may be more convenient than the printed word.

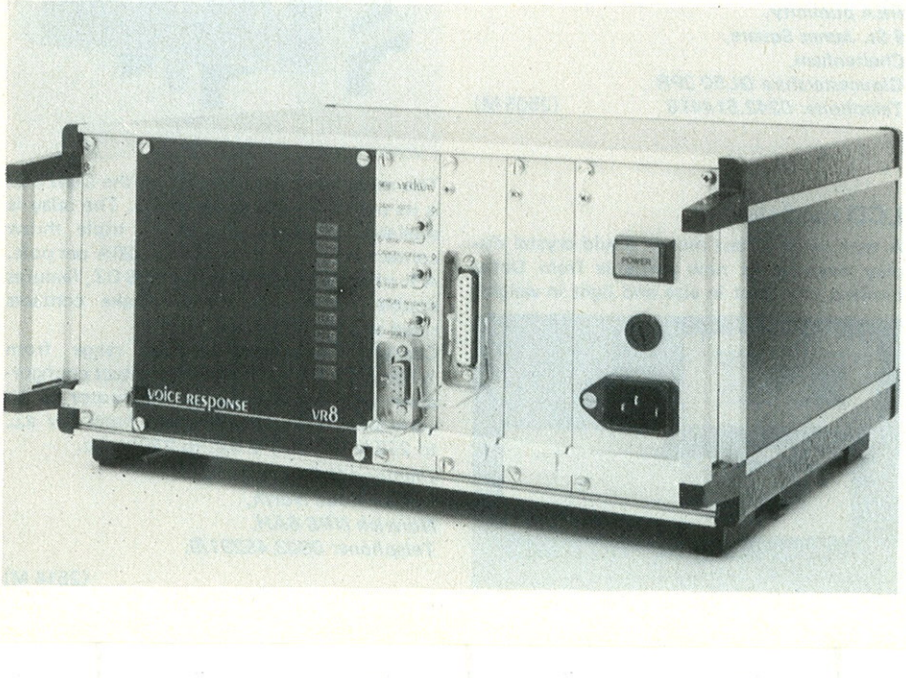
This device provides an inexpensive, simple to use method of communicating with a computer for the non-technical user. The Voice Response Unit can easily be added to virtually any business computer and is compatible with View Data Systems. Speech which may be recorded by the user is held in ROM. Other manufacturer's speech systems, such as National Semiconductors 'Digitalker' with large vocabulary, are standard options on the VR8.

For users who require a lengthy or constantly changing vocabulary there is the highly sophisticated, multi track, cassette tape option, the VR5. This unit enables the user to change or add recordings by using a conventional plug in microphone. The VR5 has the unique ability to search for speech during data entry and of having more than one recording at a given location which, together with its high search speed, virtually eliminates response delays. Applications responding to the same computer program but in more than one language are also within the capabilities of this unit. The VR5 and VR7 may be combined providing both tape and solid state memory in a single unit.

The Unit is available with a standard RS 232C interface and both IBM and ICL interactive protocols are also catered for.

Medway Data Limited,
Victoria House,
Grover Street,
Tunbridge Wells,
Kent TN1 2QB
Telephone: 0892.44462

(2502 M)



Heating controller

This unit is designed to control the temperatures inside buildings enabling central heating systems (oil, gas, electricity) to work more economically and therefore save direct energy.

It provides a 4 program daily cycle controling the temperature at any given period. These programs are totally independent and therefore it is possible to select day and night temperatures separately as desired. The display functions as a clock as well as a thermometer. The different programs may be called, verified and changed individually.

This unit replaces conventional mechanical thermostats without additional wiring and it has an additional advantage; the hysteresis may be programmed at choice. It is also possible to control the unit manually without disturbing any of the pre-selected-programs. The main savings are obtained by a more accurate measuring of time and temperature and precise ON and OFF switching, eliminating mechanical tolerances. The unit is built around a specially designed 'single chip microcomputer' and based on the most advanced technologies.

It is available in kit-form and also as a built and tested unit.

Velleman (U.K.) Limited,
P.O. Box 30,
St. Leonards-on-Sea,
East Sussex TN37 7NL
Telephone: 0424.753246

(2507 M)

market

High-specification, low-cost test equipment

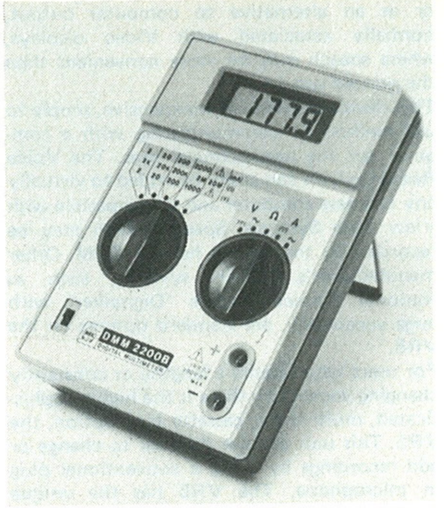
Sifam Ltd of Torquay is now marketing a range of test instruments and accessories.

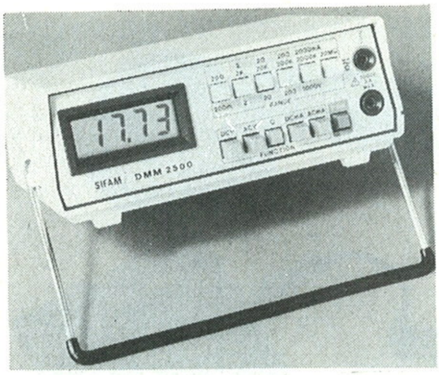
Available now (all with one-year guarantee, prices exclusive of VAT) are: **Handheld 3½ digit (1999) multimeter, model DMM2200B,** priced at £ 43.43, offers 21 ranges in five modes: DC & AC voltage and current, and resistance. Said to have a basic accuracy of 0.3 per cent (DCV), the instrument will operate continuously for 1000 hours from a standard 9 V radio-type battery, and has overload protection, autozero and autopolarity facilities as well as over-range and low-battery indications.

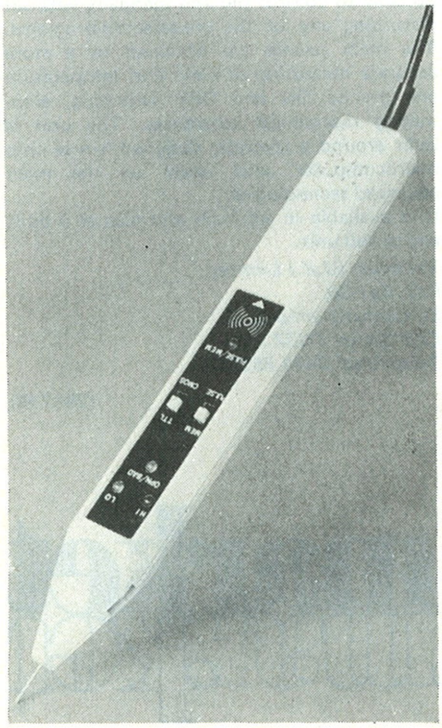
Robustly constructed, two rotary switches provide clear and simple colour-coded selection of measurement mode and range, and the read-out is by 12 mm high LCD digits. It measures 165 x 110 x 43 mm, weighs 360 grammes with battery, and is supplied complete with test leads, spare fuse, battery and operators' manual.

3½ digit (1999) bench multimeter, model DMM2500, priced at £ 66.04: 24 ranges in the same five DC/AC measurement modes, with the same order of accuracy and operational features, but with push-button function/range switching and 2000 hours battery life and circuit-breaker overload protection. It has a built-in bench stand/handle and measures 155 x 120 x 57 mm, weighs 383 grammes with battery. It is supplied with test leads, battery and manual.

Digital logic probe, model DLP50, compatible with DTL, TTL and CMOS standards, this too, says Sifam, offers exceptional value for money at £ 39.09. It has an input frequency range of DC to 50 MHz, a minimum detectable input pulse width of 10 nanosecs, high input impedance of 10 megohms, power range of 4.5 to 30 V DC with input protection (including an audible warning) up to ± 120 V DC or AC. Three-colour LEDs signal: high (red), low (green), open-circuit/bad level (yellow) and pulse/memory (red). The audible alarm sounds if an input signal exceeds the operating voltage of the circuit under test, or when a voltage in excess of 30 V DC is applied to the probe input, if the power lead is connected in reverse or with AC line. The probe is fitted with a 800 mm long power lead, and has a consumption of 50 mA maximum at 5 V DC. Dimensions of the probe itself are 195 x 26 x 16 mm and it weighs 70 grammes. Supplied in a moulded carrying case, it comes complete with ground and IC clip leads and operating manual.





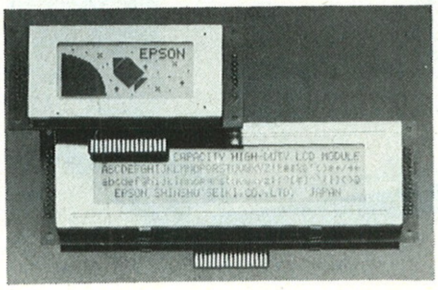


REA publicity,
6 St. James Square,
Cheltenham,
Gloucestershire GL50 3PR
Telephone: 0242.514418

(2505 M)

LCD modules

A new range of dot matrix liquid crystal display modules, is now available from Datac Limited. Compact in size and light in weight, Epson EA series LCD modules are available with character formats ranging from 16 x 1 line to 80 x 4 lines and a dot format of 84 columns x 32 rows.


EPSON
CAPACITY HIGH-DUTY LCD MODULE
EPSON SHINSHU SEIKI CO.,LTD. JAPAN

Operating on a 5 V DC power supply, with a consumption of 0.6 to 3 ma, EA and EG LCDs have a high contrast display for easy readability. Backlighting can be provided.

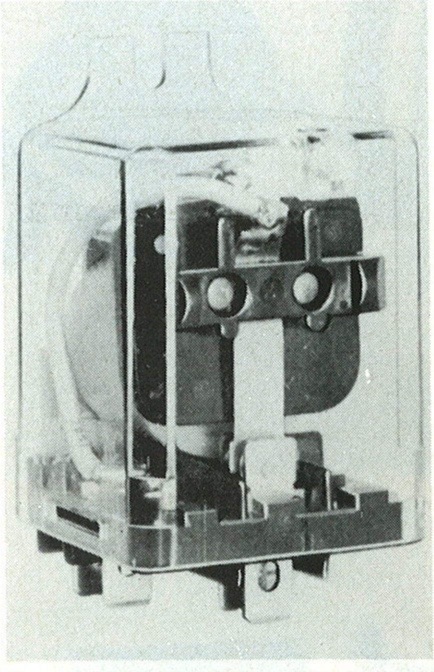
EA and EG series modules have a built-in Data RAM (80 Bytes) and character generator (160 ch based on ASCII code). The modules will operate at any temperature from 0 to 50°C and have a response time (turn on/turn off) of 150 ms. The design life is 50,000 hours.

Datac Limited,
Tudor Road,
Altrincham,
Cheshire WA14 5TN.
Telephone: 061.941.2361/2.

(2521 M)

20 A relay

Introduced as the Magnacraft Class 389, this new power relay features extremely high contact ratings for its size: it can be supplied in open style, which measures 2.1 in. long x 1.45 in. wide x 1.28 in. high; or with a clear plastic flange-mount cover, measuring overall 2.9 in. long x 1.5 in. wide x 1.4 in. high. Its base incorporates quick-connect/solder terminals.



The most important feature of the Class 389 is its power switching capability. The relay is available in single, double or triple throw contact configurations rated at 20A per pole. A further version, designated 389 DZ, features double break and double make contacts rated at 30A.

Contact horsepower ratings range from ½ hp to 1½ hp, according to contact configuration and the voltage of the motor to be controlled. Coil voltages range from 6 V a.c. to 277 V a.c. or 6 V d.c. to 220 V d.c.

Diamond H Controls Ltd.,
Vulcan Road North,
Norwich NR6 6AH.
Telephone: 0603.45291/9.

(2514 M)

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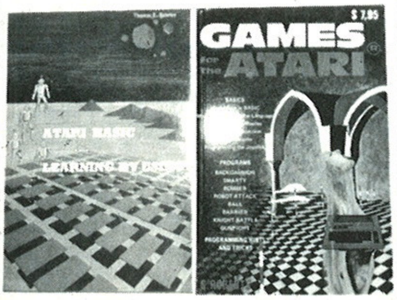
Pomona CA 91766,
Phone: (714) 623–8314

PRODUCTS FOR ATARI* 400/800 FROM ELCOMP

BOOKS:

ATARI BASIC – Learning by using
An excellent book for the beginner. Many short programs and learning exercises. All important features of the ATARI computers are described (screen drawings, special sounds, keys, paddles, joysticks, specialized screen routines, graphics, sound applications, peeks, pokes, and special stuff). Also suggestions are made that challenge you to change and write program routines.
Order #164 **$7.95**



GAMES for the ATARI Computer
This book describes advanced programming techniques like player-missile-graphics and use of the hardware-registers. Contains many ready to run programs in BASIC and one called GUNFIGHT in machine-Language.
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SOFTWARE IN BASIC FOR ATARI

Invoice Writing for Small Business
This program makes writing invoices easy. Store your products in DATA statements with order-number, description, and price. The program later retrives the description and price matching to the entered order-number. The shipping cost and the discount may be calculated automatically depending on the quantity ordered or entered manually. The description to the program tells you how to change the program and adapt it to your own needs. Comes with a couple of invoice forms to write your first invoices on to it.

Order #7201	**cassette version**	**$29.95**
Order #7200	**disk version**	**$39.95**

Mailing List
This menu driven program allows the small business man to keep track of vendors and customers. You can search for a name or address of a certain town or for an address with a certain note. 50 addresses are put into one file.

Order #7212	**cassette version**	**$19.95**
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Inventory Control
This program is menu driven. It gives you the following options: read/store data, define items, entry editing, inventory maintenance (incoming-outgoing), reports. The products are stored with inventory number, manufacturer, reorder level, present level, code number, description.

Order #7214	**cassette version**	**$19.95**
Order #7215	**disk version**	**$24.95**

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The programs from book no. 164 on cassette. (Book included)
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Games on cassette. (Bomber, tennis, smart, cannon fodder, etc.)
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Descriptions, pinouts and specifications of the most popular microprocessors and support chips.
A MUST for the hardware buff.

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Care and Feeding of the Commodore PET
Eight chapters exploring PET hardware. Includes repair and interfacing information. Programming tricks and schematics.
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SOFTWARE IN MACHINE LANGUAGE for ATARI

ATMONA-1
This is a machine language monitor that provides you with the most important commands for programming in machine-language. Disassemble, dump (hex and ASCII), change memory location, block transfer, fill memory block, save and load machine-language programs, start programs. Printer option via three different interfaces.

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Order #7023	**disk version**	**$24.95**
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ATMONA-2
This is a tracer (debugger) that lets you explore the ATARI RAM/ROM area. You can stop at previously selected address, opcode, or operand. Also very valuable in understanding the microprocessor. At each stop, all registers of the CPU may be changed. Includes ATMONA-1.

Order #7049	**cassette version**	**$49.95**
Order #7050	**disk version**	**$54.00**

ATMAS
Macro-Assembler for ATARI-800/48k. One of the most powerful, editor assemblers on the market. Versatile editor with scrolling. Up to 17k of source-Code. Very fast, translates 5k source-code in about 5 seconds. Source code can be saved on disk or cassette. (Includes ATMONA-1)

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Order #7999	**cartridge version**	**$129.00**

ATAS
Same as ATMAS but without macro-capability. Cassette-based.

Order #7098	**32k RAM**	**$49.95**
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This wordprocessor is an excellent buy for your money. It features screen oriented editing, scrolling, string search (even nested), left and right margin justification. Over 30 commands. Text can be saved on disk or cassette.

Order #7210	**cassette version**	**$29.95**
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GUNFIGHT
This game (8k machine-language) needs two joystieks. Animation and sound. Two cowboys fight against each other. Comes on a bootable cassette.
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ELCOMP FORTH is an extended Fig-Forth-version, Editor and I/O package included. Utility package includes decompiler, sector copy, Hex-dump (ASCII), ATARI Filehandling, total graphic and sound, joystickprogram and player missile. Extremely powerfull
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PRINTER INTERFACE
This construction article comes with printed circuit board and software. You can use the EPSON printer without the ATARI printer interface. (Works with gameports 3 and 4).
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RS-232 Interface for your ATARI 400/800
Software with connector and construction article.
Order #7291 **$19.95**

EPROM BURNER for ATARI 400/800
Works with gameports. No additional power supply needed. Comes compl. assembled with software (2716, 2732, 2532).
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Printed circuit board incl. Software and extensive construction article.
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EPROM BOARD (CARTRIDGE)
Holds two 4k EPROMs (2532). EPROMs not included.
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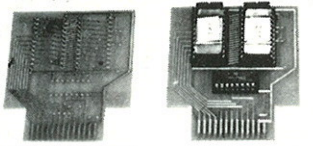

EPROM BOARD KIT
Same as above but bare board only with description.
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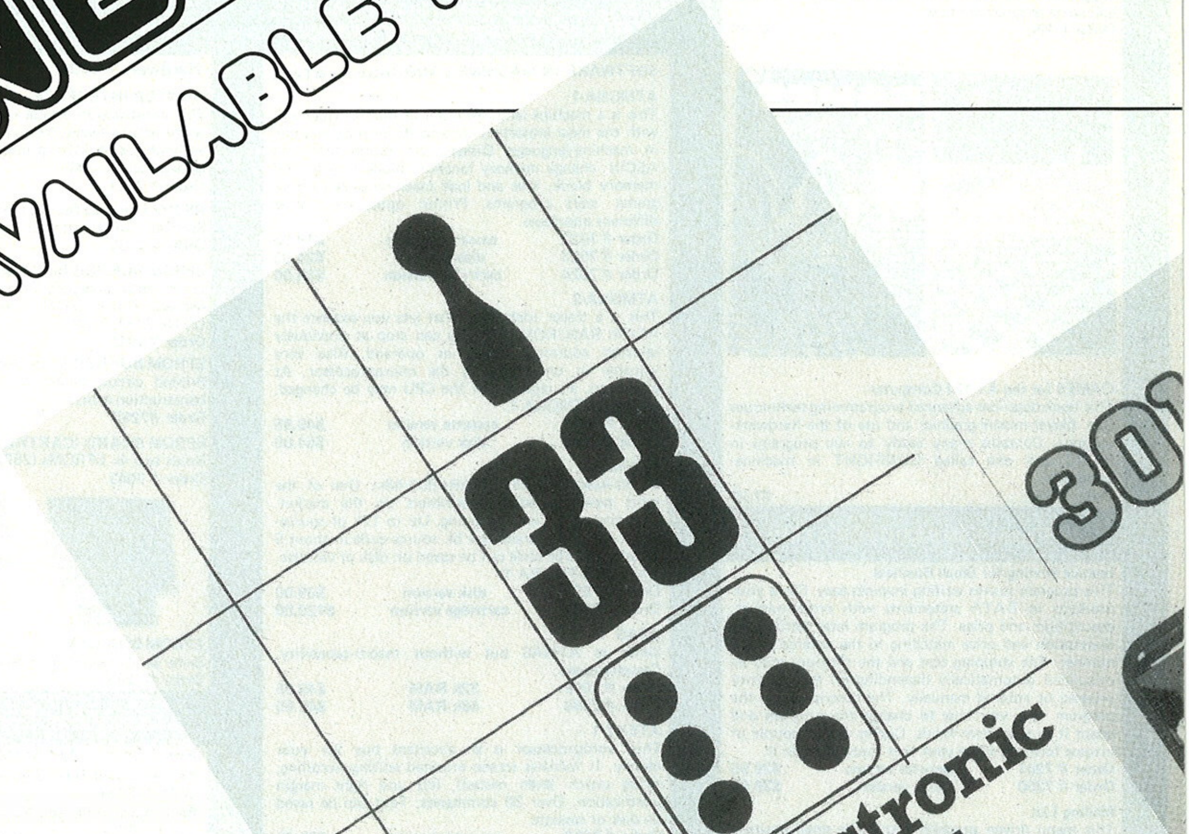


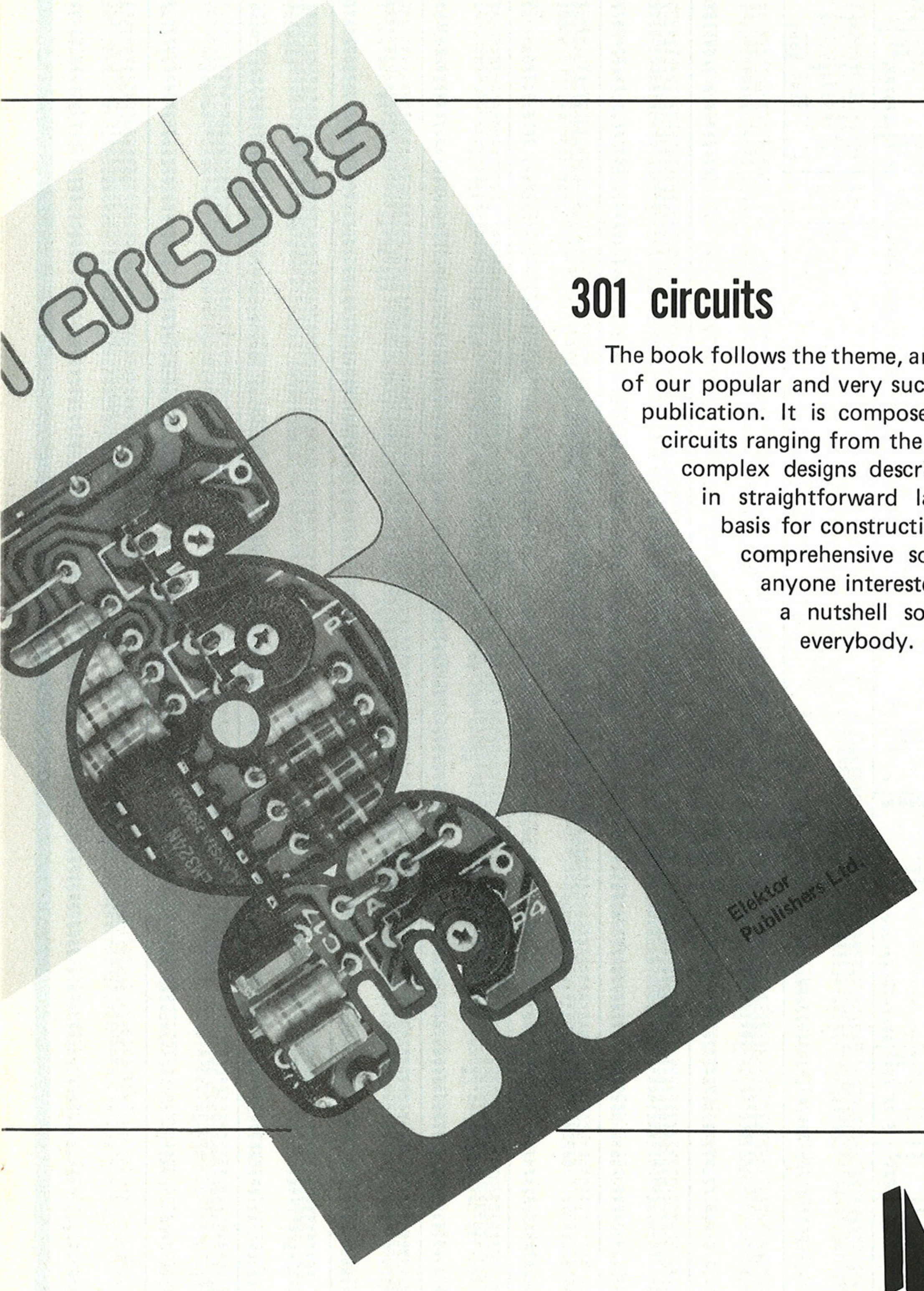
33
electronic games

A selection of circuits which give as much enjoyment in building them as actually playing the games. The circuits are fascinating although the electronics involved are not complex and therefore anyone with a good soldering iron will find this book satisfying. These are electronic games that do not need a TV screen, and as a result can be played just about anywhere.

elektor

Elektor publishers Ltd.
Elektor house 10 Longport
Canterbury CT1 2BR

new books from elektor



301 circuits

The book follows the theme, and is a continuation of our popular and very successful 300 circuits publication. It is composed of 301 assorted circuits ranging from the simple to the more complex designs described and explained in straightforward language. An ideal basis for constructional projects and a comprehensive source of ideas for anyone interested in electronics. In a nutshell something to please everybody.

CRICKLEWOOD ELECTRONICS LTD

40 CRICKLEWOOD BROADWAY, LONDON NW2 3ET. Tel: 01-4520161 TELEX: 914977 CRIKEL G

SUPERIOR QUALITY CARBON FILM RESISTORS' HISTAB LOW NOISE

¼ W 10 Ω - 1MΩ 5% E24	2p
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1 W 10Ω - 10MΩ 5% E12	6p
2 W 10Ω - 10MΩ 5% E12	15p

METAL OXIDE/FILM RESISTORS

Very high thermal & electrical stability. Extremelu low noise

0.4 W 10Ω - 1MΩ 2% E24	5p
0.1 W 10Ω - 1MΩ 1% E24	8p

LOW OHMIC VALUE RESISTORS (½ W OR ¼ W)

0.22Ω - 8.2Ω E12	11p

WIREWOUND RESISTORS 5%

2.3 W 0.22Ω - 330Ω E12	28p
4.7 W 0.47Ω - 6K8 E12	33p
10 - 11 W 1.0Ω - 33K E12	37p

LOW NOISE ROTARY POTS
E3 Series

4.7K - 2M Lin	32p
4.7K - 2M Log	32p
As above with DP switch	80p
As above but stereo (no switch)	90p

MICRO-MINI 100V CERAMIC PLATE CAPS
5% or better
E12 Series
1pF - 10nF 7p
DISCOUNTS ON QUANTITY PLEASE PHONE

SIEMENS 63V MINI MONOLYTHIC CERAMIC

10nF	10p
22nF	10p
33nF	10p
47nF	10p
68nF	10p
100nF	14p

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1nF - 68nF	10p
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5% 7.5mm 100V CAPACITORS E12

100nF-180nF	12p
220nF-270nF	15p
330nF-390nF	20p
470nF-560nF	27p
680nF	32p
1µF (10mm)	35p

Complete range of other voltages & spacings in stock.
Please phone

ICE MULTI-METERS
Microtest 80 £ 16.00
Supertest 680R £ 32.00

TANTALUM BEADS

.1/35 V	17p
.22/35 V	17p
.33/35 V	17p
.47/35 V	17p
.68/35 V	17p
1.0/35 V	17p
2.2/16 V	17p
2.2/35 V	22p
3.3/35 V	22p
4.7/16 V	22p
4.7/35 V	24p
6.8/25 V	26p
6.8/35 V	25p
10/16 V	25p
10/35 V	34p
15/10 V	22p
15/25 V	32p
22/6.3 V	26p
22/16 V	32p
33/10 V	38p
47/6.3 V	43p
100/3 V	37p

Feedthrough Capacitor
1000pF 500V 7p

MINI FILM MULLARD TRIMMERS

1.4 - 5pF (800MHz)	23p
2 - 10 pF (600MHz)	27p
2 - 22pF (400MHz	29p
5.5 - 65pF (200MHz)	36p

630VDC 250VAC POLYESTER CAPS

10nF	12p
15nF	18p
22nF	18p
47nF	32p
100nF	35p
150nF	37p
220nF	40p

Fully enclosed Piher Pre sets
E 3 Series
100Ω 10M

Cermet 20 Turn Precision Preset:
50Ω, 100Ω, 200Ω, 500Ω, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 250K, 500K
99p eac'

Mini Vert	14p
Mini Horiz	14p
Standard Vert	17p
Standard Horiz	17p
Thumbwheel or ¼" Spindle for Standard Pre sets only	8p

160V Polystyrene Caps 5% or better
10pF, 15pF, 22pF, 27pF, 33pF, 39pF, 47pF, 68pF, 100pF, 150pF, 180pF, 220pF, 270pF, 330pF, 390pF, 470pF, 680pF, 820pF, 1nF, 1 5nF, 2 2nF, 3.3nF, 4 7nF, 10nF
12p each

C280 or Equiv Polyester Caps Radial Long Leads

10nF, 15nF, 22nF, 33nF, 47nF, 68nF, 100nF	9p
150nF, 220nF	11p
330nF, 470nF	16p
680nF, 1µF	24p
1 5µF, 2.2µF	44p

Veroboard 0.1" Copper Clad

2.5 × 3.75	72p
2.5 × 5	80p
3.75 × 3.75	80p
3.75 × 5	93p
2.5 × 17	2.50
3.75 × 17	3.30
4.79 × 17	4.20
VQ Board	1.50
Dip Board	3.25
Track Cutter	1.15
Pin Insertor	1.59
100 Pins	.50
Verobloc	3.70

Vero Wiring

Pen + Spool	3.00
Spare Spool	72p
Combs	6p

Ferric Chloride
60% Solution
250ml bottle £1.60

Quality Electrolytics
By Matsushita or Siemens
(other good makes may be sent only in the rare event of supply difficulty)
AXIALS

uFd	V	
.47	63	8p
.47	100	9p
.47	350	30p
1	63	8p
1	100	9p
1	500	40p
2.2	25	8p
2.2	63	9p
2.2	100	11p
2.2	350	30p
3.3	25	10p
3.3	40	11p
3.3	63	12p
4.7	16	8p
4.7	25	9p
4.7	40	11p
4.7	63	12p
4.7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	17p
47	63	26p
47	100	28p
68	25	18p
68	63	25p
100	16	14p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	25p
220	63	30p
220	100	40p
330	16	19p
330	25	22p
330	63	38p
470	16	22p
470	25	28p
470	40	33p
470	63	43p
470	100	60p
1000	16	30p
1000	25	38p
1000	40	46p
1000	63	65p
2200	16	40p
2200	25	63p
2200	40	70p
2200	63	134p
4700	16	75p
4700	25	90p

Cermet 20 Turn Precision Presets
50Ω, 100Ω, 200Ω, 500Ω, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 250K, 500K
99p eac'

1000vdc Caps (300VAC) Axial

1nF, 2.2nF	23p
4 7nF, 6.8nF	26p
10nF	28p
22nF, 33nF	37p
47nF	45p
100nF	48p
220nF	74p
470nF	1.10

1500VDC Caps (300VAC) Axial

1nF, 2.2nF	30p
3 3nF, 4.7nF	32p

2000VDC Axial
100nF 20% 76p

Ceramic Hi Volt Disc Capacitors

100p/1KV	20p
100p/2KV	24p
100p/3KV	26p
100p/4KV	28p
220p/6KV	30p
470p/2KV	27p
470p/6KV	32p
1n/2KV	28p
1n/6KV	32p
2n2/2KV	30p
2n2/4KV	32p
2n2/5KV	33p
3n3/2KV	31p
3n3/4KV	32p
4n7/4KV	33p

400V Polyester Capacitors

1nF, 1 5nF, 2 2nF	18p
3.3nF, 4 7nF, 6.8nF	19p
10nF, 15nF, 22nF	20p
33nF, 47nF, 68nF	22p
100nF, 150nF	25p
220nF	38p
330nF	58p
470nF	66p

ETCH RESIST TRANSFERS

1. Thin lines
2. Thick lines
3. Thin bends
4. Thick bends
5. DIL pads
6. Transistor pads
7. Dots + holes
8. 0.1" edge cons.
9. Mixture

any sheet of above 30 p
Set of 13 sheets 3.00

Wire & Cable
Prices per metre
Solid Hook up Wire
Any colour 5p

Beautiful Mini Radial Low Voltage
Matsushita only

uFd	V	
10	16	6p
22	10	6p
22	16	7p
47	10	7p
47	16	8p
100	10	9p
100	16	10p
220	10	11p
220	16	12p
470	10	17p
470	16	18p
1000	10	20p
1000	16	24p
2200	10	34p
2200	16	44p

Mains/Speaker Cable (per metre)

Twin 1 amp	14p
Twin 2½ amp	16p
3 Core 2½ amp	18p
3 Core 6 amp	31p
3 Core 13 amp	56p

Solid Multicore

4 Core	33p
8 Core	39p
12 Core	48p
50 Core	1.37

Screened Cable

Single	14p
Stereo	27p
Mini Single	12p
Mini Stereo	15p
4 Core 4 Screens	44p
4 Core 1 Screen	54p
8 Core	61p
12 Core	80p

Aerial Cable

50Ω RG58A	36p
75Ω UHF	36p
75Ω VHF	28p
300Ω Flat	14p

Rainbow Ribbon Cable

10 Way	65p
24 Way	152p
40 Way	210p

PHOTO SENSITIVE PCB
1st Class Epoxy Glass. For better results than spraying. Expose to UV

Single sided

100 × 160	1.55
100 × 220	1.90
203 × 114	1.85
233 × 220	3.99

Double sided

100 × 160	1.65
100 × 220	2.15
203 × 114	2.21
233 × 220	4.55

Developer for above (do not use Sodium Hydroxide)
500 ml 2.50

DALO ETCH RESIST PEN
+ spare nib 90p

ANTEX SOLDERING IRONS

C240 (15W)	4.59
X25 (25W)	4.99
Iron stand	1.65
C240 Element	1.99
X25 Element	2.05

Bits C240

No 2 (Small)	65p
No 3 (Med)	65p
No 6 (Lge)	65p

Bits X25

No 50 (Small)	65p
No 51 (Med)	65p
No 52 (Lge)	65p

SOLDER
125gms

18 swg	2.95
22 swg	3.10

DIL SOCKETS

Pins	Lo-prof	W.Wp.
8	8 p	25 p
14	9 p	35 p
16	10 p	40 p
18	16 p	50 p
20	20 p	–
22	22 p	–
24	24 p	70 p
28	28 p	79 p
40	30 p	99 p

TRANSISTORS
Probably the largest retail variety in UK
If you don't see what you want please phone or write as this is not a full list

2N404	1.50
2N914	20p
2N916	39p
2N917	65p
2N918	33p
2N929	36p
2N929A	45p
2N930	20p
2N930A	30p
2N1131	24p
2N1132	25p
2N1302	45p
2N1303	65p
2N1304	60p
2N1306	65p
2N1308	65p
2N3170	58p
2N1420	66p
2N1483	2.95
2N1485	3.47
2N1507	42p
2N1524	58p
2N1702	3.20
2N1711	35p
2N1889	50p
2N1890	50p
2N1893	30p
2N1974	1.50
2N2060	7.14
2N2102	39p
2N2217	39p
2N2218	33p
2N2218A	25p
2N2219	27p
2N2219A	28p
2N2220	22p
2N2221	22p
2N2221A	23p
2N2222	24p
2N2222A	25p
2N2223	2.60
2N2223A	4.15
2N2303	39p
2N2368	25p
2N2369	19p
2N2369	18p
2N2405	88p
2N2410	1.15
2N2411	3.60
2N2412	80p
2N2477	95p
2N2483	25p
2N2484	26p
2N2491	8.00
2N2646	45p
2N2647	98p
2N2714	12p
2N2848	60p
2N2875	2.20
2N2890	1.10
2N2891	2.28
2N2892	3.00
2N2904A	27p
2N2905	28p
2N2905A	29p
2N2906	25p
2N2906A	30p
2N2907	25p
2N2907A	26p
2N2920	3.47
2N2923	25p
2N2924	15p
2N2925	15p
2N2926	10p
2N3010	75p
2N3011	25p
2N3019	50p
2N3053	27p
2N3054	56p

2N3055CSF	60p
2N3055RCA	80p
2N3107	46p
2N3108	42p
2N3109	48p
2N3232	1.50
2N3250	36p
2N3251	36p
2N3300	60p
2N3301	68p
2N3302	80p
2N3390	38p
2N3391	30p
2N3391A	34p
2N3392	27p
2N2393	24p
2N3394	20p
2N3395	26p
2N3396	26p
2N3397	27p
2N3402	35p
2N3403	50p
2N3404	50p
2N3405	50p
2N3416	24p
2N3417	23p
2N3420	2.50
2N3439	98p
2N3440	80p
2N3441	1.25
2N3442	1.35
2N3442MOT	2.40
2N3444	1.70
2N3445	4.80
2N3446	6.09
2N3447	5.72
2N3448	6.56
2N3468	1.00
2N3512	1.06
2N3553	2.30
2N3563	20p
2N3564	25p
2N3565	20p
2N3566	50p
2N3567	55p
2N3568	50p
2N3569	50p
2N3570	2.54
2N3571	2.19
2N3572	2.06
2N3584	2.76
2N3585	2.99
2N3605	36p
2N3606	28p
2N3607	28p
2N3632	9.88
2N3638	35p
2N3638A	37p
2N3639	36p
2N3641	39p
2N3642	25p
2N3643	15p
2N3644	28p
2N3645	33p
2N3646	28p
2N3662	15p
2N3663	16p
2N3691	18p
2N3692	20p
2N3693	25p
2N3694	30p
2N3702	10p
2N3703	10p
2N3704	10p
2N3705	10p
2N3706	10p
2N3707	10p
2N3708	10p
2N3709	10p
2N3710	10p
2N3711	10p
2N3712	2.00
2N3713	1.38
2N3714	2.98
2N3715	3.31
2N3716	3.60
2N3724	75p
2N3725	85p
2N3730	4.65
2N3732	2.88
2N3734	1.30
2N3725	2.45
2N3738	2.00
2N3740	2.38
2N3741	2.76
2N3766	2.90
2N3767	3.19
2N3771	1.75
2N3772	1.83
2N3773	2.06
2N3779	1.70
2N3789	3.27
2N3790	2.73
2N3791	2.47
2N3792	2.68
2N3749	25p
2N3819	21p
2N3820	38p
2N3821	1.84
2N3822	90p
2N3823	45p
2N3824	1.70
2N3826	78p
2N3827	78p
2N3854	44p
2N3855	30p
2N3855A	40p
2N3856	45p
2N3858	31p
2N3858A	37p
2N3859A	31p
2N3860	31p
2N3866	90p
2N3877A	35p
2N3900	25p
2N3901	30p
2N3902	6.65
2N3903	15p
2N3904	15p
2N3905	15p
2N3906	15p
2N3945	85p
2N3962	30p
2N3964	1.42
2N4030	66p
2N4031	55p
2N4032	65p
2N4036	58p
2N4037	43p
2N4058	10p
2N4059	17p
2N4060	12p
2N4061	10p
2N4062	10p
2N4064	1.15
2N4069	1.00
2N4074	75p
2N4092	98p
2N4093	1.20
2N4121	45p
2N4122	45p
2N4123	21p
2N4124	35p
2N4125	37p
2N4126	27p
2N4220	75p
2N4221	95p
2N4222	97p
2N4223	97p
2N4224	98p
2N4234	45p
2N4236	45p

2N4237	1.21
2N4238	95p
2N4239	1.00
2N4240	3.00
2N4248	15p
2N4249	17p
2N4250	17p
2N4258	75p
2N4266	45p
2N4275	48p
2N4284	32p
2N4285	35p
2N4287	45p
2N4288	22p
2N4289	15p
2N4290	45p
2N4291	45p
2N4292	45p
2N4294	45p
2N4297	2.50
2N4302	39p
2N4303	40p
2N4304	41p
2N4314	60p
2N4342	68p
2N4347	2.26
2N4351	1.16
2N4400	15p
2N4401	27p
2N4402	30p
2N4403	30p
2N4409	36p
2N4410	42p
2N4427	79p
2N4440	12.58
2N4870	80p
2N4871	55p
2N4888	92p
2N4898	1.29
2N4901	1.69
2N4902	3.52
2N4903	3.24
2N4904	2.75
2N4905	3.25
2N4906	3.42
2N4907	3.20
2N4908	3.70
2N4909	2.90
2N4910	1.95
2N4913	2.59
2N4914	2.69
2N4915	2.95
2N4916	48p
2N4917	47p
2N4918	95p
2N4919	1.28
2N4920	1.34
2N4921	55p
2N4922	69p
2N4923	99p
2N4924	92p
2N4926	95p
2N4927	95p
2N4928	1.59
2N4964	27p
2N4965	25p
2N4966	25p
2N4967	25p
2N4968	25p
2N4969	31p
2N5010	8.50
2N5011	9.37
2N5030	44p
2N5033	48p
2N5036	1.60
2N5036	1.95
2N5039	3.90
2N5086	36p
2N5087	39p
2N5088	37p
2N5089	37p
2N5126	48p
2N5217	38p
2N5128	38p
2N5129	30p
2N5130	37p
2N5131	22p
2N5133	22p
2N5135	38p
2N5136	38p
2N5137	23p
2N5138	18p
2N5139	48p
2N5140	25p
2N5141	25p
2N5143	25p
2N5172	15p
2N5175	58p
2N5179	39p
2N5180	43p
2N5183	1.00
2N5184	1.10
2N5188	1.15
2N5189	1.00
2N5190	68p
2N5191	70p
2N5193	90p
2N5194	79p
2N5209	24p
2N5210	25p
2N5219	25p
2N5220	15p
2N5221	25p
2N5222	28p
2N5223	15p
2N5224	38p
2N5225	25p
2N5226	25p
2N5227	25p
2N5232	30p
2N5232A	32p
2N5245	37p
2N5246	40p
2N5247	45p
2N5248	46p
2N5249	48p
2N5266	2.88
2N5293	98p
2N5294	1.28
2N5295	1.37
2N5296	1.28
2N5298	1.37
2N5302	3.20
2N5303	3.80
2N5305	25p
2N5306	37p
2N5307	40p
2N5308	25p
2N5354	19p
2N5355	19p
2N5358	73p
2N5366	25p
2N5367	28p
2N5401	35p
2N5415	1.10
2N5416	1.54
2N5447	16p
2N5448	19p
2N5449	21p
2N5450	23p
2N5451	25p
2N5457	29p
2N5458	29p
2N5459	29p
2N5460	72p
2N5461	60p
2N5462	80p
2N5484	40p
2N5485	29p
2N5490	1.37
2N5492	1.56
2N5494	1.37
2N5496	1.59

2N5543	5.00
2N5551	37p
2N5640	45p
2N5654	35p
2N5786	80p
2N5813	23p
2N6027	30p
2N6030	6.60
2N6082	11.99
2N6099	1.20
2N6101	1.30
2N6109	1.15
2N6111	1.00
2N6121	54p
2N6122	56p
2N6123	59p
2N6124	56p
2N6125	59p
2N6126	71p
2N6129	79p
2N6130	93p
2N6131	98p
2N6132	83p
2N6133	1.14
2N6134	1.36
2N6253	1.45
2N6254	1.55
2SC1306	95p
2SC1444	2.50
2SC2078	1.70
2SJ49	3.98
2SJ82	3.98
2SK134	3.98
2SK226	3.98
3N139	3.30
3N140	2.37
3N143	2.85
3N152	3.00
3N153	2.47
3N154	2.56
3N200	6.93
3N201	2.98
40250	95p
40251	2.77
40254	2.75
40264	2.63
40280	2.00
40290	2.00
40309	1.80
40311	97p
40312	1.64
40313	1.89
40315	1.94
40316	95p
40324	1.86
40325	2.46
40326	1.98
40346	1.30
40347	89p
40348	1.95
40360	60p
40361	67p
40362	67p
40363	2.22
40364	2.90
40372	1.80
40373	2.60
40374	2.84
40389	1.24
40390	2.72
40392	1.20
40394	1.10
40394	1.70
40406	1.39
40407	75p
40408	1.59
40410	1.80
40411	2.85
40412	90p
40422	2.95
40467A	1.29
40513	1.75
40537	96p
49543	1.60
40594	99p
40595	99p
40600	2.58
40601	2.36
40602	1.68
40603	1.09
40604	1.85
40608	2.44
40622	1.45
40625	1.60
40626	3.20
40631	1.90
40631	2.12
40635	1.35
40637	2.00
40643	1.80
40673	83p
40822	1.80
40871	89p
40872	89p
AC125	35p
AC126	25p
AC127	25p
AC128	25p
AC132	39p
AC151	51p
AC152	45p
AC153	55p
AC153K	64p
AC176	27p
AC176K	37p
AC187	25p
AC187K	28p
AC188	25p
AC188K	40p
ACY17	70p
ACY18	90p
ACY20	75p
ACY21	75p
ACY22	75p
ACY28	75p
ACY44	98p
AD136	7.90
AD145	1.65
AD149	79p
AD150	1.31
AD161	39p
AD162	39p
AF106	75p
AF109	75p
AF114	65p
AF117	70p
AF118	89p
AF124	72p
AF125	72p
AF126	72p
AF139	53p
AF170	88p
AF172	88p
AF178	88p
AF200	65p
AF201	75p
AF239	1.24
AF240	1.00
AF279B	75p
AF279G	75p
AL102	3.49
AU110	2.20
AU113	2.30
BC107	10p
BC107A	12p
BC107B	12p
BC108	10p
BC108A	12p
BC108B	12p
BC108C	14p
BC109	10p
BC109B	12p
BC109C	12p

BC113	30p
BC114	19p
BC115	22p
BC116	32p
BC116A	37p
BC117	19p
BC118	19p
BC119	38p
BC121	82p
BC123	82p
BC125	37p
BC132	39p
BC134	36p
BC135	45p
BC136	45p
BC137	39p
BC138	55p
BC140	29p
BC141	37p
BC142	29p
BC143	34p
BC147	10p
BC147A	10p
BC147B	10p
BC147C	20p
BC148	10p
BC148A	12p
BC148B	13p
BC148C	13p
BC149	10p
BC149B	12p
BC149C	13p
BC152	35p
BC153	23p
BC154	27p
BC157	11p
BC157A	12p
BC157B	13p
BC158	10p
BC158A	12p
BC158B	13p
BC159	11p
BC159A	12p
BC159B	13p
BC159C	18p
BC160	42p
BC161	48p
BC167	10p
BC167A	10p
BC167B	13p
BC168	10p
BC168B	10p
BC168C	10p
BC169	10p
BC169B	10p
BC169C	10p
BC170	15p
BC170A	17p
BC170B	17p
BC170C	18p
BC171	12p
BC171A	15p
BC171B	15p
BC172	12p
BC172A	15p
BC172B	15p
BC172C	16p
BC173	11p
BC173B	16p
BC173C	16p
BC174	21p
BC174A	24p
BC174B	24p
BC175	75p
BC177	16p
BC177A	25p
BC177B	26p
BC178	16p
BC178A	24p
BC178B	25p
BC179	20p
BC179A	25p
BC179B	25p
BC179C	27p
BC182	10p
BC182A	12p
BC182B	13p
BC182L	10p
BC182LA	13p
BC182LB	14p
BC183	10p
BC183A	11p
BC183B	12p
BC183C	13p
BC183L	10p
BC183LA	13p
BC183LB	13p
BC183LC	14p
BC184	10p
BC184B	12p
BC184C	13p
BC184L	10p
BC184LB	13p
BC184LC	14p
BC196	24p
BC187	24p
BC204	29p
BC205	29p
BC206	29p
BC207	29p
BC208	29p
BC209	29p
BC212	10p
BC212A	12p
BC212B	13p
BC212L	10p
BC212LA	13p
BC212LB	14p
BC213	10p
BC213A	11p
BC213B	12p
BC213C	13p
BC213L	10p
BC213LB	13p
BC213LC	14p
BC214	10p
BC214B	12p
BC214C	13p
BC214L	10p
BC214LB	13p
BC214LC	14p
BC237	14p
BC237A	16p
BC237B	17p
BC237C	18p
BC238	14p
BC238A	15p
BC238B	16p
BC238C	17p
BC239	15p
BC239A	16p
BC239B	17p
BC239C	18p
BC250	22p
BC250A	23p
BC250B	24p
BC250C	25p
BC251	25p
BC251A	26p
BC251B	27p
BC251C	28p
BC252	22p
BC252B	23p
BC252C	24p
BC253	22p
BC253B	23p
BC253C	24p
BC256	25p
BC256A	26p
BC256B	27p
BC257	26p
BC257A	27p
BC258	24p

BC258A	25p
BC258B	26p
BC259	25p
BC259B	26p
BC259C	27p
BC260	30p
BC260B	32p
BC260C	33p
BC261	33p
BC261A	34p
BC261B	35p
BC261C	36p
BC262	31p
BC262A	32p
BC262B	33p
BC262C	34p
BC263	30p
BC263B	31p
BC263C	32p
BC264	40p
BC264B	42p
BC266	35p
BC266A	36p
BC266B	37p
BC300	45p
BC301	44p
BC302	43p
BC303	47p
BC304	46p
BC307	13p
BC307A	14p
BC307B	15p
BC308	12p
BC308A	13p
BC308B	14p
BC309	14p
BC309A	15p
BC309B	16p
BC309C	17p
BC317	15p
BC318	15p
BC320	25p
BC321	25p
BC327	14p
BC328	14p
BC337	15p
BC338	15p
BC347	20p
BC350	20p
BC382	30p
BC382L	30p
BC383	30p
BC383L	30p
BC384	30p
BC384L	30p
BC407	30p
BC408	24p
BC409	30p
BC413	25p
BC414	25p
BC415	30p
BC416	30p
BC418	30p
BC440	32p
BC441	33p
BC460	32p
BC461	33p
BC478	29p
BC479	30p
BC516	40p
BC517	40p
BC547	13p
BC547A	14p
BC547B	14p
BC548	12p
BC548A	13p
BC548B	14p
BC548C	15p
BC549	13p
BC549B	14p
BC549C	15p
BC550	30p
BC550C	33p
BC557	15p
BC557A	16p
BC557B	16p
BC558	14p
BC558A	15p
BC558B	16p
BC559	15p
BC559B	16p
BC559C	17p
BC560	32p
BC560C	34p
BC727	44p
BC737	44p
BCW32R	60p
BCY30	1.15
BCY30A	1.30
BCY31	1.15
BCY31A	1.30
BCY32	1.15
BCY32A	1.30
BCY33	80p
BCY33A	1.00
BCY34	80p
BCY34A	80p
BCY54	1.91
BCY58	32p
BCY59	33p
BCY66	1.80
BCY67	2.00
BCY70	16p
BCY71	16p
BCY72	19p
BCY77	34p
BCY78	22p
BCY79	22p
BCY87	6.60
BCY88	4.90
BCY89	4.10
BCZ10	4.60
BCZ11	4.60
BD115	58p
BD116	2.50
BD121	2.25
BD124	1.50
BD131	44p
BD132	44p
BD135	40p
BD136	40p
BD137	42p
BD138	39p
BD139	39p
BD140	39p
BD142	2.40
BD153	1.25
BD155	1.20
BD157	54p
BD158	55p
BD160	3.80
BD181	1.75
BD182	2.50
BD183	2.70
BD187	1.09
BD201	1.30
BD202	1.39
BD204	1.44
BD220	1.00
BD221	95p
BD223	1.00
BD224	95p
BD232	1.11
BD233	70p
BD234	72p
BD237	98p
BD238	98p
BD239A	57p
BD239C	64p
BD240A	59p
BD240C	73p
BD241A	61p
BD241C	67p

BD242A	65p
BD242C	70p
BD243A	72p
BD143C	85p
BD244A	82p
BC244C	1.00
BD245A	1.14
BD245C	1.30
BD246A	1.20
BD246C	1.50
BC249A	2.00
BC249C	2.31
BD250A	2.11
BD250C	2.46
BD433	79p
BD434	55p
BD435	81p
BD436	81p
BD437	88p
BD438	88p
BD439	90p
BD440	91p
BD441	91p
BD442	93p
BD529	1.20
BD530	1.30
BD535	75p
BD536	75p
BD537	80p
BD538	80p
BD539	80p
BD539C	1.10
BD540	85p
BD540C	1.20
BD675	72p
BD676	77p
BD677	78p
BD678	83p
BD711	1.32
BD712	1.32
BDX14	1.30
BDX18	1.59
BDX32	3.47
BDY10	2.00
BDY11	2.50
BDY17	2.89
BDY23	3.40
BDY25	3.75
BDY38	1.74
BDY54	1.70
BDY55	1.75
BDY56	1.80
BDY57	5.25
BDY58	6.15
BDY60	1.60
BDY61	2.80
BDY62	2.34
BDY92	3.75
BF115	35p
BF119	1.00
BF121	75p
BF123	70p
BF127	80p
BF153	39p
BF154	25p
BF157	58p
BF158	25p
BF159	58p
BF160	55p
BF161	58p
BF163	50p
BF166	57p
BF167	29p
BF170	79p
BF173	25p
BF174	77p
BF177	25p
BF178	30p
BF179	35p
BF180	35p
BF181	36p
BF182	36p
BF183	38p
BF184	36p
BF185	37p
BF194	12p
BF195	12p
BF196	12p
BF197	12p
BF198	15p
BF199	15p
BF200	1.49
BF224J	32p
BF225J	35p
BF240	38p
BF241	38p
BF244A	35p
BF244B	39p
BF245A	
BF245B	51p
BF246	52p
BF246A	
BF246B	51p
BF247A	54p
BF247B	55p
BF254	39p
BF255	42p
BF256A	35p
BF256B	45p
BF256C	62p
BF257	30p
BF258	32p
BF259	35p
BF262	80p
BF263	90p
BF270	65p
BF271	68p
BF273	40p
BF274	40p
BF324	38p
BF336	36p
BF337	28p
BF338	48p
BF355	60p
BF362	85p
BF363	85p
BF457	46p
BF458	56p
BF459	62p
BF469	86p
BF470	86p
BFR39	25p
BFR40	25p
BFR41	25p
BFR79	25p
BFR80	25p
BFR81	25p
BFR90	2.11
BFS28	2.95
BFS61	1.00
BFS98	1.10
BFT19	1.65
BFT19B	1.88
BFT66	2.48
BFW10	1.48
BFW10	1.48
BFW11	1.48
BFW43	2.47
BFW59	1.06
BFW87	1.53
BFW90	1.53
BFX12	1.00
BFX13	91p
BFX19	50p
BFX20	80p
BFX29	26p
BFX30	27p
BFX34	1.00
BFX37	70p
BFX43	70p
BFX68	1.00
BFX84	27p
BFX85	28p

BFX86	28p
BFX87	25p
BFX88	26p
BFX89	1.75
BFY18	48p
BFY19	1.10
BFY37	1.20
BFY39	50p
BFY41	1.16
BFY50	23p
BFY51	23p
BFY52	23p
BFY53	31p
BFY56	31p
BFY56A	68p
BFY75	75p
BFY76	50p
BFY77	80p
BFY78	80p
BFY90	79p
BSV81	1.87
BSW41	95p
BSW67	1.00
BSW70	1.00
BSX19	24p
BSX20	24p
BSX21	40p
BSX26	34p
BSX27	78p
BSX28	66p
BSX29	34p
BSX39	80p
BSX60	75p
BSX61	80p
BSX76	50p
BSX77	55p
BSY24	77p
BSY25	1.00
BSY26	35p
BSY29	70p
BSY39	47p
BSY54	40p
BSY65	58p
BSY95A	25p
BU104	2.22
BU105	1.70
BU109	3.29
BU126	1.47
BU204	2.25
BU205	1.75
BU206	1.89
BU208	1.98
BU326S	2.35
BU406	1.45
BU407	1.45
BU408	1.35
BU409	1.25
BU500	2.95
BUV20	11.00
BUV21	10.90
BUV23	13.60
BUV24	12.10
BUV25	15.00
BUX20	17.00
BUY18S	3.95
J300	48p
J310	53p
MA8001	45p
MA8002	62p
MA8003	39p
MD7000	2.60
ME0401	25p
ME0402	30p
ME0404	25p
ME0411	35p
ME0412	35p
ME0413	35p
ME0414	48p
ME0461	45p
ME0462	45p
ME1001	45p
ME1002	45p
ME1075	45p
ME1100	45p
ME1120	48p
ME3002	25p
ME4001	45p
ME4002	45p
ME4003	45p
ME4101	25p
ME4101	25p
ME4103	25p
ME4104	25p
ME6001	25p
ME6002	25p
ME6003	25p
ME6101	29p
ME6102	28p
ME8001	47p
ME8002	62p
ME8003	50p
ME9001	56p
ME9002	56p
MFE3004	2.36
MJ400	2.98
MJ420	2.26
MJ430	2.98
MJ440	
MJ481	1.69
MJ491	1.72
MJ802	3.99
MJ900	2.90
MJ901	3.10
MJ1000	2.50
MJ1001	3.00
MJ1800	3.60
MJ2500	2.19
MJ2501	2.25
MJ2955	1.00
MJ3000	2.19
MJ3001	2.25
MJ3701	2.55
MJ4502	3.99
MJE340	53p
MJE370	97p
MJE371	99p
MJE520	92p
MJE521	94p
MJE1090	3.65
MJE1100	3.65
MJE2901	3.65
MJE2955	99p
MJE3055	69p
MP8111	1.00
MP8112	1.39
MP8121	1.35
MP8122	1.40
MP8123	1.16
MP8512	1.59
MPF102	39p
MPF103	29p
MPF104	29p
MPF105	29p
MPF112	59p
MPF121	1.69
MPS3638	27p
MPS3640	40p
MPS4356	60p
MPS6517	47p
MPS6518	47p
MPS6530	37p
MPS6560	32p
MPS6562	32p
MPSA05	23p
MPSA06	25p
MPSA10	28p
MPSA12	29p
MPSA13	48p
MPSA14	46p
MPSA16	30p
MPSA18	65p
MPSA20	48p
MPSA18	65p

MPSA42	49p
MPSA43	49p
MPSA55	28p
MPSA56	30p
MPSA65	40p
MPSA66	47p
MPSA70	45p
MPSA92	39p
MPSA93	39p
MPSL01	42p
MPSL51	48p
MPSU01	84p
MPSU04	1.32
MPSU05	55p
MPSU06	56p
MPSU07	75p
MPSU51	88p
MPSU55	58p
MPSU56	59p
MPSU57	1.20
MRF421	poa
MRF453	poa
MRF454	poa
MRF475	7.55
MRF477	poa
MRF479	poa
MRF604	poa
NKT124	63p
NKT125	49p
NKT126	47p
NKT128	42p
NKT129	40p
NKT135	40p
NKT137	42p
NKT210	42p
NKT215	40p
NKT216	65p
NKT218	44p
NKT219	40p
NKT224	40p
NKT225	40p
NKT229	40p
NKT238	46p
NKT239	44p
NKT240	42p
NKT241	40p
NKT242	40p
NKT243	86p
NKT243	86p
NKT244	40p
NKT254	40p
NKT261	40p
NKT262	40p
NKT271	40p
NKT272	40p
NKT275	40p
NKT281	47p
NKT404	2.68
NKT405	2.80
NKT406	2.50
NKT453	2.40
NKT603F	56p
NKT613F	55p
NKT674F	55p
NKT677F	55p
NKT713	47p
NKT717	52p
NKT734	55p
NKT736	58p
NKT773	40p
NKT781	43p
NKT12329	50p
NKT12429	57p
NKT13329	50p
NKT13429	54p
NKT16229	59p
NKT20329	38p
OC20	2.30
OC22	2.00
OC23	2.00
OC25	2.50
OC28	1.70
OC29	2.35
OC35	2.35
OC41	80p
OC43	70p
OC44	82p
OC70	50p
OC71	50p
OC72	50p
OC82	50p
OC82D	70p
OC83	75p
P346A	58p
R2008B	2.14
R2010B	1.88
SC107	27p
SC108	27p
SC109	27p
TIP29A	32p
TIP29C	38p
TIP30A	35p
TIP30C	38p
TIP31A	38p
TIP31C	39p
TIP32A	38p
TIP32C	42p
TIP33A	65p
TIP33C	78p
TIP34A	74p
TIP34C	88p
TIP35A	1.09
TIP35C	1.28
TIP36A	1.29
TIP36C	1.39
TIP41A	49p
TIP41C	55p
TIP42A	55p
TIP42C	65p
TIP49	1.20
TIP50	1.40
TIP53	1.57
TIP54	1.59
TIP110	74p
TIP112	90p
TIP115	81p
TIP117	96p
TIP120	69p
TIP122	73p
TIP125	1.20
TIP127	1.27
TIP130	1.50
TIP132	1.60
TIP135	1.60
TIP137	1.80
TIP140	1.04
TIP142	1.04
TIP145	1.19
TIP147	1.19
TIP2955	77p
TIP3055	70p
TIS37	62p
TIS43	40p
TIS45	66p
TIS46	66p
TIS47	49p
TIS48	65p
TIS49	66p
TIS50	60p
TIS51	65p
TIS52	70p
TIS53	97p
TIS54	85p
TIS55	66p
TIS58	92p

CRICKLEWOOD-STOCKING PARTS OTHER STORES CANNOT REACH!

Items not fully covered on this list include: **OPTO:** 7 seg LEDs, LCDs, bezelled LEDs, Lamps, Lampholders. **FUSES:** 20 mm, 1¼ inch, slow or quick blow, Fuseholders. **CONNECTORS:** DIL, DIN, Phono, 1 mm, 2 mm, 4 mm, Bulgin, USA, I.E.C. **KNOBS:** Plastic, Aluminium, Anodised, Collet, Pointer. **SWITCHES:** Toggle, Biased, Rocker, Rotary, Slide, DIL, Push. **METERS:** LCD, Analogue, Test and Panel. **TOOLS:** Pliers, Cutters, Strippers, Trimmers, Cable Cutters. And much, much more . . . .
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TIS60	42p
TIS62	44p
TIS64	67p
TIS87	60p
TIS88A	62p
TIS90	28p
TIS91	30p
TIS92	30p
TIS93	54p
VN10KM	60p
VN46AF	84p
VN66AF	85p
ZTX107	10p
ZTX108	10p
ZTX109	10p
ZTX300	13p
ZTX301	15p
ZTX302	15p
ZTX303	23p
ZTX304	15p
ZTX310	35p
ZTX311	32p
ZTX312	35p
ZTX313	36p
ZTX314	24p
ZTX320	35p
ZTX330	35p
ZTX341	28p
ZTX500	14p
ZTX501	14p
ZTX502	14p
ZTX503	17p
ZTX504	24p
ZTX510	34p
ZTX530	24p
ZTX531	25p

DIACS

BR100	40p
ST2	25p

THYRISTORS
Sensitive Gate
Small Signal

2N5060	30p
2N5061	32p
2N5062	35p
2N5063	37p
2N5064	40p
BR101	75p
BRY39	60p
BRY55-100	60p
BRY55-300	67p
BRY56	50p
TIC44	35p
TIC47	50p

4, 8 & 12 Amps Texas TO220
Suffix: A = 100V
B = 200V
C = 300V
D = 400V
M = 600V

4A	TIC106A	46p
	TIC106B	47p
	TIC106C	48p
	TIC106D	59p
	TIC106M	68p
8A	TIC116A	68p
	TIC116B	68p
	TIC116C	71p
	TIC116D	73p
	TIC116M	80p
12A	TIC126A	72p
	TIC126B	72p
	TIC126C	73p
	TIC126D	77p
	TIC126M	95p

SIEMENS THRISTORS

1.2 amp plastic	
Bst B0106 (100V)	60p
Bst B0113 (200V)	70p
Bst B0146 (700V)	1.12
4.7 amp plastic	
Bst B0206 (100V)	80p
Bst B0213 (200V)	1.10
Bst B0246 (700V)	2.00

TV Thyristors

2N4444	1.80
BT101-500R	1.40
BT106	1.50
BT116 Use TIC116M	
BT119	1.70
BT120	1.50
BT121	1.30

TRIACS
Texas 400V
TO220 Case

TIC206D(4A)	66p
TIC225D(6A)	74p
TIC226D(8A)	88p
TIC236D(12A)	1.16
TIC246D(16A)	1.22
TIC253D(20A)	1.90
TIC263D(25A)	2.11

Other Triacs

2N5756 (TO5)	1.44
2N6155 (TO127)	3.39
40432 (Quadrac)	2.23
40486 (TO5)	1.65
40512	2.70
40576 (TO66)	3.33
40842	1.92

DIODES

1N34A	30p
1N821	70p
1N823	92p
1N914	4p
1N916	6p
1N1190	1.47
1N1192	1.75
1N1194	1.65
1N1194A	1.80
1N1196A	2.41
1N1198A	2.65
1N1201A	97p
1N1204A	1.00
1N1206	1.20
1N3063	36p
1N3065	48p
1N3492	1.85

1N3493	2.20
1N3493R	2.20
1N3602	36p
1N3604	45p
1N3766	3.00
1N3768	4.50
1N3768R	4.50
1N4001	4p
1N4002	4½p
1N4003	5p
1N4004	5½p
1N4005	6p
1N4006	6½p
1N4007	7p
1N4009	20p
1N4148	6p
1N4150	18p
1N4448	22p
1N4517	22p
1N5172	30p
1N5176	94p
1N5400	12p
1N5401	13p
1N5492	14p
1N5403	15p
1N5404	16p
1N5405	17p
1N5406	18p
1N5407	19p
1N5408	20p
1N5024	52p
1N5625	60p
1N5626	62p
1N5627	68p
1S44	10p
1S131	40p
1S134	56p
1S421	1.00
1S421R	1.00
1S940	10p
1S941	11p
1S961	22p
AA119	28p
AA129	57p
AA144	25p
AAY30	44p
AAY33	46p
AAZ17	27p
BA100	22p
BA102	25p
BA115	25p
BA133	40p
BA138	30p
BA142	20p
BA144	15p
BA155	15p
BA156	38p
BA182	40p
BA201	18p
BA202	26p
BA316	25p
BA317	25p
BA318	30p
BAV10	16p
BAV19	15p
BAV20	15p
BAV49	15p
BAX13	10p
BAX16	11p
BAY38	20p
BAY44	15p
BAY93	10p
BB103B	70p
BB103G	70p
BB104B	80p
BB104G	80p
BB105	52p
BB105A	57p
BB105B	58p
BB109G	65p
BY126	20p
BY127	22p
BY134	52p
BY182	1.26
BY188A	65p
BY206	36p
BY207	36p
BY223	1.56
BY297	48p
BY299	55p
BYW11-800	1.40
BYW11-1000	2.00
BYW12-100	1.30
BYW12-200	1.40
BYW12-400	2.00
BYX10	36p
BYX50-200R	2.00
BYX55-350	62p
BYX71-350	1.10
BYX71-600	1.52
ITT33	15p
ITT44	10p
ITT921	10p
ITT923	15p
ITT2002	27p
MZ2361	1.80
OA10	70p
OA47	20p
OA90	10p
OA91	10p
OA95	20p
OA200	20p
OA202	20p
RAS508AF	75p
SPD9000	75p
SPD9002	95p

2 amp type	
Square with hole	
S01 (100)	37p
S02 (200)	40p
S04 (400)	40p
S08 (800)	55p

BRIDGE RECTIFIERS
(PIV shown in brackets)

1 amp type	
W01 (100)	20p
W02 (200)	26p
W04 (400)	28p
W08 (800)	40p
6 amp type	
Square with hole	
PW01 (100)	50p
PW02 (200)	78p
PW04 (400)	85p
PW06 (600)	90p
25 amp type	
Metal clad with hole	
K01 (100)	2.20
K02 (200)	2.30
K04 (400)	2.80
K06 (600)	3.40

Proprietory Bridges

B40C1500	1.20
B80C3700	1.80
BY164	55p
BY179	92p

ZENER DIODES
400-500 mW
E24 Series
2.4-47 V 8p

1.3 Watt
E24 Series
3.3-82 V 15p

2.5 Watt
E24 Series
7.5-75V 1.10

5W wire ended following voltages only 3V3, 3V6, 4V3, 4V7, 5V6, 7V5, 8V2, 8V7, 9V1, 10V, 12V, 20V, 33V, 51V, 62V, 68V 1.25

10W Pos. Stud
Following voltages only 7V5, 13, 18, 20, 24, 27, 30, 33, 68, 82, 91, 100, 110 1.25

20W Pos. Stud
(BZY93 series)
E24 values
7V5-75V 2.00

OPTO ELECTRONICS

2N5777	78p
2N5778	88p
2N5779	1.09
4N25	1.10
BP100	1.40
BP104	1.00
BPX25	2.47
BPX29	2.47
BPX48	6.76
BPX60	4.75
BPX61	3.48
BPX63	2.93
BPX79	4.60
BPX86	4.15
CQX13	40p
CQX23	53p
CQX33	48p
LD30A	10p
LD36A	12p
LD37A	12p
LD52A	12p
LD56A	15p
LD57A	15p
LD52C	30p
LD56C	30p
LD57C	30p
LD80A	18p
LD86A	22p
LD87A	22p
LD242	75p
LD271	40p
LD461	25p
LD466	1.45
LD468	1.65
LD471	27p
LD476	1.20
LD478	1.45
LD479	1.65
LD481	27p
LD486	1.25
LD488	1.70
LD489	1.89
LD599	81p
ORP12	1.20
RPY60	2.65
RPY63	2.65
TIL32	71p
TIL63	1.95
TIL64	1.95
TIL65	2.25
TIL66	2.30
TIL67	2.35
TIL78	60p
TIL81	1.60
TIL99	1.35
TIL116	1.10
TIL138	2.40
TIL139	2.40
TIL209	15p
TIL211	19p
TIL212	19p
TIL224	32p
TIL228	42p
TIL312	1.65
TIL313	1.65
TIL401	3.50
TIL403	3.80
TIL406	4.10

NEW OPTO DEVICES

inc. Superbright see next column.

POWERFET AMP MODULES FROM PANTECHNIC
now available from LONDON.
Send s.a.e. for specs.

PFA 100	16.00
PFA 200	22.55
10,000 mF 80 V	4.10

D. CONNECTORS 25 WAY

Solder type	
Male	1.60
Fmale	2.05
Angled PCB	
Male	2.45
Fmale	2.90
Covers	99p

NEW OPTO DEVICES
New LEDs
Now in stock
R = red
G = green
Y = yellow

Large diffused	1+	50+
R5D	9p	7p
G5D	15p	12p
Y5D	15p	12p

Small diffused		
R2D	8p	6p
G2D	12p	10p
Y2D	12p	10p
Micro 0.1"		
R1D	25p	22p
G1D	27p	25p
Y1D	27p	25p
Large clear		
R5C	12p	10p
G5C	17p	13p
Y5C	17p	13p
Super bright Large (100 times brighter)		
R5U	38p	29p
G5U	42p	34p
Y5U	42p	34p
Tri-colour flat		
RGY8	83p	78p

LINEAR ICs

AN103	2.20
AY1-0212	6.60
AY3-0215	7.95
AY1-1320	2.20
AY1-5050	95p
AY1-1270	7.26
AY3-8910	5.39
AY3-8912	5.59
AY5-2376	5.89
CA3000	4.80
CA3001	4.95
CA3002	4.60
CA3005	3.15
CA3007	4.92
CA3010	1.30
CA3012	1.75
CA3013	4.12
CA3014	2.35
CA3015	2.62
CA3018	75p
CA3018A	2.00
CA3020	2.00
CA3020A	3.90
CA3021	3.20
CA3022	3.12
CA3026	1.52
CA2028A	1.21
CA3028B	2.53
CA3029	1.44
CA3030A	2.97
CA3033	5.44
CA3034	5.18
CA3036	2.75
CA3039	1.50
CA3041	3.47
CA3042	3.47
CA3043	3.92
CA3046	69p
CA3047	4.60
CA3048	2.99
CA3049	3.21
CA3050	4.11
CA3051	3.80
CA3052	2.92
CA3053	1.00
CA3054	1.66
CA3059	2.80
CA3060	4.09
CA3062	13.84
CA3065E	4.62
CA3068	4.23
CA3070	3.20
CA3071	3.30
CA3075	2.25
CA3076	3.42
CA3078T	2.25
CA3080	1.89
CA3080A	3.95
CA3080E	70p
CA3081	1.90
CA3085	1.35
CA3086	55p
CA3089E	1.95
CA3090AQ	3.70
CA3130E	87p
CA3130T	1.80
CA3140E	39p
CA3140T	85p
HA1366W	2.40
HA1388	2.54
ICL7106	7.40
ICL7107	9.50
ICL8038	2.99
ICM7555	80p
LC7120	3.20
LC7130	3.20
LF351	47p
LF353	92p
LF355	83p
LF356	92p
LF357	1.09
LF13201	2.99
LF13331	3.30
LF13741H	68p
LF13741N	59p
LM10CH	4.25
LM11CH	4.50
LM114	6.75
LM137K	11.52
LM301AH	1.00
LM301AN	25p
LM305AH	2.90
LM305H	88p
LM307H	1.05
LM307N	55p
LM308AH	3.15
LM308AN	2.14
LM308H	95p
LM308N	88p
LM309K	2.80
LM310H	1.95
LM310N	1.89
LM311H	1.04
LM311N	70p
LM317K	2.80
LM317MP	1.04
LM318H	2.40
LM318N	1.49
LM319H	2.48
LM319N	2.10
LM320 — See 79XX Series Volt Regulators	
LM324N	29p
LM337K	4.75
LM337MP	1.65
LM337T	1.99
LM339AN	1.60
LM339N	47p
LM340 — See 78XX Series Volt Regulators	
LM345K	3.60
LM348N	62p
LM349N	1.16
LM350K	4.60
LM359N	1.44
LM360N	3.88
LM376N	65p
LM377N	1.69
LM378N	3.40
LM379S	4.79
LM380N14	75p
LM380N8	1.50

LM381AN	2.26
LM381N	1.40
LM382N	1.12
LM383T	3.40
LM384N	1.40
LM386N1	88p
LM386N4	1.20
LM388N	2.43
LM391N60	1.70
LM391N80	1.93
LM392N	76p
LM393N	96p
LM394H	3.80
LM396K	13.52
LM709N8	64p
LM709CH	1.00
LM710CH	89p
LM710CN	52p
LM711CH	1.38
LM711CN	70p
LM723CH	1.21
LM723CN	40p
LM725CH	3.40
LM725CN	3.19
LM733CN	69p
LM741CH	96p
LM741CN	15p
LM741CN14	80p
LM747CN	69p
LM748CH	1.00
LM748CN	35p
LM1303N	1.20
LM1304N	2.50
LM1305N	3.10
LM1307N	2.75
LM1310N	1.45
LM1330N	2.25
LM1458	44p
LM1496	1.08
LM1800	3.24
LM1801	2.99
LM1812	8.00
LM1818	2.99
LM1820	2.15
LM1828	4.79
LM1830	2.44
LM1845	4.12
LM1848	2.89
LM1850	2.75
LM1871	4.39
LM1872	4.39
LM1886	7.44
LM1889	3.77
LM2907N	2.75
LM2907NB	2.60
LM2917N	1.89
LM2917N8	1.89
LM3524	6.77
LM3301	1.60
LM3302	74p
LM3401	65p
LM3404	75p
LM3405	1.45
LM3900	48p
LM3905	1.25
LM3909	79p
LM3911	1.20
LM3914	1.79
LM3915	1.99
LM3916	2.19
LM4250CH	2.63
LM4250N	2.39
LM13600	1.09
MB3712	1.99
MB3756	3.80
MB8719	7.95
M53200	8.54
MC1303= LM1303N	
MC1304= LM1304N	
MC1305= LM1305N	
MC1307= LM1307N	
MC1310= LM13010N	
MC1330= LM1330N	
MC1352	1.75
MC1456	1.80
MC1458= LM1458	
MC1466L	6.77
MC1495L	3.75
MC1496= LM1496	
MC3340	1.45
MC3401= LM3401	
MC3403= LM3403	
MC3405= LM3405	
NE531N	1.36
NE543N	2.50
NE544N	1.80
NE555	16p
NE556	45p
NE558	1.89
NE560	3.25
NE562	4.09
NE565	1.18
NE566	1.49
NE567	1.37
NE570	3.75
NE571	3.75
NE5534	1.49
PLL02A	4.95
PLL03A	12.75
RC4136	59p
S556B	2.59
SAD1024A	8.49
SAS560	2.59
SAS570	2.59
SAS580	2.59
SAS590	2.59
SFF96364	7.99
SL610C	4.00
SL611C	4.00
SL612C	4.00
SL620C	6.00
SL621C	6.00
SL623C	10.00
SL630C	6.00
SL640C	6.00
SL641C	6.00
SN76001N	2.80
SN76008	3.90
SN76018	3.90
SN76003N	2.95
SN76013N	2.95
SN7023N= SN76033N	
SN76033N	2.95
SN76110	2.25
SN76115	2.65
SN76116	2.75
SN76226	3.45
SN76228	2.90
SN76477	4.49
SN76530	1.80
SN76550	80p
SN76666	2.90
SO41P	1.60
SO42P	1.60
TA7210	1.49
TA7204	1.95
TA7205	89p

TA7222	1.45
TA7310	1.49
TAA263	1.50
TAA300	3.95
TAA320	2.05
TAA350	3.60
TAA521	1.50
TAA522	2.47
TAA550	73p
TAA560	2.35
TAA570	2.35
TAA621AX1	2.75
TAA661A	1.50
TAA661B	1.70
TAA700	2.60
TAA930	2.50
TAA930B	2.63
TAA970	2.45
TAA991D	2.45
TAD100	2.00
TBA120AS	69p
TBA331	1.50
TBA341	2.05
TBA395	1.65
TBA396	1.50
TBA450	1.95
TBA460	1.53
TBA500	2.97
TBA500Q	3.11
TBA510	2.95
TBA510Q	3.05
TBA520	2.57
TBA520Q	2.75
TBA530	2.55
TBA530Q	2.76
TBA540	2.72
TBA540Q	2.74
TBA550	3.25
TBA550Q	3.27
TBA560C	2.87
TBA570	2.37
TBA570Q	2.48
TBA581	3.11
TBA641	3.00
TBA651	1.90
TBA673	4.15
TBA700	2.38
TBA700Q	2.47
TBA720AQ	2.60
TBA750	2.25
TBA750Q	2.46
TBA790A	2.11
TBA800	78p
TBA810	95p
TBA820	75p
TBA820M	75p
TBA920	1.95
TBA920Q	1.97
TBA950	2.25
TBA990	2.65
TBA990Q	2.74
TCA105	3.00
TCA160C	2.67
TCA220	3.44
TCA270	2.44
TCA440	2.20
TCA450	2.65
TCA640	4.15
TCA650	4.15
TCA660B	4.15
TCA730	4.80
TCA740	4.80
TCA750	4.85
TCA760	2.75
TCA800	3.50
TBA800Q	3.60
TCA830S	1.90
TCA910	2.19
TCA940	1.69
TDA1002	3.39
TDA1003	3.94
TDA1004	3.94
TDA1005	3.94
TDA1010A	1.79
TDA1022	4.95
TDA1024	1.19
TDA1034	3.20
TDA2020	2.99
TDA2030	2.85
TDA2522	4.20
TDA2530	3.30
TDA2540	4.10
TDA2541	4.10
TDA2560	4.10
TDA2571	4.40
TDA2581	3.75
TDA2590	5.20
TDA2591	4.73
TDA2600	6.15
TDA2610	3.90
TDA2611A	2.50
TDA2640	3.64
TDA3000	2.76
TL061	40p
TL062	60p
TL064	99p
TL071	36p
TL072	50p
TL074	1.30
TL081	50p
TL082	75p
TL083	85p
TL084	89p
TL170	49p
TL430	69p
UAA170	1.69
UAA180	1.69
ULN2003	85p
UPC575C2	2.65
UPC1156	2.75
XR2206	2.92
ZN414	79p
ZN419	2.25
ZN1034	1.99
ZN1040	6.69
ZTK22	89p
ZTK33	89p

TTL

7400	10½p
7401	11p
7402	11p
7403	12p
7404	12p
7405	15p
7406	20p
7407	20p
7408	14p
7409	14p
7410	14p
7411	16p
7412	18p
7413	18p
7414	25p
7416	20p
7417	20p
7420	15p
7421	20p
7422	20p
7423	20p
7425	24p
7426	28p
7427	22p
7428	26p
7430	14p
7432	22p
7433	22p
7437	25p
7438	25p
7440	15p
7441	65p
7442	32p
7443	90p
7444	90p
7445	50p
7446	60p
7447	40p
7448	44p
7450	15p
7451	15p
7453	15p
7454	14p
7460	15p
7470	34p
7472	25p
7473	25p
7474	20p
7475	25p
7476	28p
7480	49p
7481	1.19
7482	68p
7483	38p
7484	69p
7485	60p
7486	20p
7489	2.20
7490	20p
7491	35p
7492	25p
7493	25p
7494	36p
7495	36p
7496	40p
7497	90p
74100	80p
74104	50p
74105	55p
74107	22p
74109	25p
74110	35p
74116	50p
74118	59p
74119	80p
74120	59p
74121	25p
74122	40p
74123	40p
74125	35p
74126	34p
74128	36p
74132	29p
74136	30p
74141	55p
74142	1.99
74143	2.48
74144	2.10
74145	50p
74147	89p
74148	70p
74150	49p
74151	40p
74153	40p
74154	49p
74155	40p
74156	40p
74157	30p
74159	75p
74160	60p
74161	48p
74162	48p
74163	48p
74164	48p
74165	48p
74166	48p
74170	1.25
74172	2.75
74173	60p
74174	59p
74175	49p
74176	39p
74177	45p
74178	79p
74180	40p
74181	1.15
74182	60p
74184	90p
74185	90p
74186	4.69
74188	2.50
74190	48p
74191	48p
74192	45p
74193	45p
74194	45p
74195	46p
74196	45p
74197	48p
74198	83p
74199	83p
74221	53p

74LS TTL

74LS00	11p
74LS01	11p
74LS02	11p
74LS03	12p
74LS04	12p
74LS05	12p
74LS08	12p
74LS10	12p
74LS11	12p
74LS12	12p
74LS13	19p
74LS14	30p
74LS15	12p
74LS20	12p
74LS21	12p
74LS22	12p
64LS27	12p
74LS28	14p
74LS30	12p
74LS32	13p
74LS33	14p
74LS37	14p
74LS38	15p
74LS40	13p
74LS42	28p
74LS47	35p
74LS51	14p
74LS54	14p
74LS55	14p
74LS73	18p
74LS74	18p
74LS75	20p
74LS76	20p
74LS78	18p
74LS80	1.20
74LS83	36p
74LS85	48p
74LS86	16p
74LS90	24p
74LS92	25p
74LS93	24p
74LS95	39p
74LS96	96p
74LS107	20p
74LS109	27p
74LS112	22p
74LS113	22p
74LS114	22p
74LS122	36p
74LS123	36p
74LS124	89p
74LS125	24p
74LS126	25p
74LS132	39p
74LS136	29p
74LS138	32p
74LS139	30p
74LS145	70p
74LS147	1.57
74LS148	75p
74LS151	39p
74LS153	39p
74LS154	79p
74LS155	29p
74LS156	36p
74LS157	27p
74LS158	29p
74LS160	35p
74LS161	35p
74LS162	35p
74LS163	35p
74LS164	40p
74LS165	59p
74LS168	84p
74LS169	85p
74LS170	70p
74LS173	55p
74LS174	45p
74LS175	39p
74LS181	99p
74LS183	1.79
74LS190	36p
74LS191	36p
74LS192	36p
74LS193	37p
74LS194	32p
74LS195	32p
74LS196	45p
74LS197	48p
74LS221	50p
74LS240	55p
74LS241	55p
74LS242	55p
74LS243	55p
74LS244	60p
74LS245	70p
74LS247	50p
74LS248	55p
74LS249	55p
74LS251	30p
74LS253	32p
74LS257	35p
74LS258	35p
74LS259	55p
74LS261	1.35
74LS266	18p
74LS273	60p
74LS275	2.25
74LS279	30p
74LS280	1.60
74LS283	40p
74LS289	4.70
74LS290	45p
74LS293	40p
74LS295	89p
74LS298	89p
74LS299	2.50
74LS323	1.76
74LS324	1.45
74LS325	2.96
74LS326	2.39
74LS327	2.39
74LS347	95p
74LS348	1.00
74LS352	79p
74LS353	79p
74LS362	7.25
74LS365	29p
74LS366	29p
74LS367	29p
74LS368	29p
74LS373	59p
74LS378	58p
74LS386	1.14
74LS390	46p
74LS393	42p
74LS395	89p
74LS396	1.90
74LS398	2.70
74LS399	1.59
74LS445	99p
74LS490	2.20
74LS540	77p
74LS541	99p
74LS640	1.60
74LS641	1.69
74LS643	2.25
74LS644	2.75
74LS669	1.20
74LS670	1.40
74LS673	5.50
74LS674	9.99
74LS688	1.19

74S TTL

74S00	30p
74S02	32p
74S04	32p
74S08	75p
74S20	60p
74S30	60p
74S32	70p
74S40	1.45
74S64	1.02
74S65	1.02
74S74	75p
74S85	2.99
74S86	1.75
74S112	90p
74S113	90p
74S124	2.95
74S132	1.09
74S133	60p
74S138	1.25
74S139	1.49
74S140	2.50
74S153	7.95
74S157	2.75
74S163	3.00
74S174	2.50
74S175	3.20
74S188	3.50
74S189	3.50
74S194	3.50
74S200	4.50
74S201	4.00
74S225	5.25
74S261	3.00
74S262	8.50
74S287	2.99
74S288	1.99
74S289	1.57
74S301	3.20
74S470	3.25
74S471	6.25
74S473	12.50
74S474	3.99
74S475	8.25
74S571	9.00
74S573	9.00

74H TTL

74H00	1.45
74H01	1.45
74H04	1.55
74H05	1.55
74H10	1.45
74H11	1.45
74H20	1.45
74H21	1.45
74H30	1.45
74H40	1.55
74H51	1.75
74H53	1.65
74H54	1.45
74H55	1.40
74H60	1.70
74H62	1.75
74H62	1.75

74L TTL

74L02	1.00
74L10	1.70
74L47	3.27
74L74	1.20
74L85	4.20
74L86	1.50
74L93	2.30
74L98	2.99

74 CMOS/TTL

74C00	27p
74C04	29p
74C10	28p
74C14	89p
74C20	28p
74C30	36p
74C42	96p
74C48	1.40
74C73	54p
74C76	57p
74C83	1.74
74C85	1.34
74C86	1.10
74C89	5.95
74C90	1.05
74C93	1.44
74C95	1.00
74C107	60p
74C151	2.55
74C154	4.95
74C157	2.20
74C160	1.54
74C161	1.15
74C162	1.16
74C163	65p
74C164	1.15
74C165	2.00
74C173	98p
74C174	65p
74C175	75p
74C192	89p
74C193	68p
74C194	89p
74C195	70p
74C200	10.00
74C221	1.20
74C901	1.91
74C902	71p
74C903	2.30
74C904	1.84
74C905	10.88
74C907	1.91
74C908	1.87
74C911	9.59
74C912	8.00
74C914	2.88
74C915	1.99
74C918	2.50
74C920D	8.50
74C922	4.50
74C923	5.00
74C925	6.00
74C926	6.58
74C928	6.00
74C929	5.20
74C930J	7.80
74C932	3.12

40 CMOS

4000	10p
4001	10p
4002	11p
4006	49p
4007	15p
4008	32p
4009	24p
4010	10p
4011	10p
4012	15p
4013	20p
4014	46p
4015	58p
4016	20p
4017	32p
4018	45p
4019	26p
4020	44p
4021	39p
4022	48p
4023	12p
4024	32p
4025	12p
4026	79p
4027	20p
4028	29p
4029	29p
4030	14p
4031	1.19
4032	80p
4033	1.20
4035	1.29
4035	59p
4036	2.49
4037	1.30
4038	99p
4039	2.80
4040	46p
4041	40p
4042	39p
4043	46p
4044	41p
4045	99p
4046	44p
4047	39p
4048	39p
4049	22p
4050	23p
4051	44p
4052	49p
4053	49p
4054	79p
4055	83p
4056	89p
4059	4.35
4060	42p
4063	79p
4066	22p
4067	2.49
4068	14p
4069	13p
4070	13p
4071	13p
4072	13p
4073	13p
4075	13p
4076	45p
4077	13p
4078	13p
4081	12p
4082	12p
4085	49p
4086	53p
4089	1.50
4093	20p
4094	69p
4095	66p
4096	90p
4097	2.88
4098	74p
4099	90p

For higher numbers in 40 Series, substitute 74C for 40 prefix. eg 40107 = 74C107

45 CMOS

4502	59p
4503	29p
4507	33p
4508	1.19
4510	35p
4511	48p
4512	39p
4514	1.17
4515	1.17
4516	59p
4518	39p
4519	29p
4520	48p
4521	99p
4526	59p
4527	59p
4528	46p
4532	69p
4534	4.29
4536	2.59
4538	65p
4539	99p
4543	56p
4553	2.25
4555	35p
4556	35p
4560	1.49
4566	1.49
4569	1.59
4584	39p
4585	79p

COMPUTER ICs
CPUs

1802	7.00
2650A	11.99
6502	3.24
6800	2.74
6802	2.69
6809	8.50
8035	3.49
8060	10.90
8080A	2.79
8085A	3.49
8900	57.75
9980	21.00
SCMP1	17.66
Z80A	2.96

MEMORIES

2101	4.00
2102AL2	1.35
2111-1	3.00
2114(200ns)	80p
2532	3.60
2708	2.25
2716 (5v)	2.11
4027	3.00
4044	7.00
4060	9.50
4116(200ns)	75p
4118-3	3.25
4164	4.50
5204	7.50
6116	4.40
6514	3.30
6810	1.15
7489	4.20
74189	4.00
74LS289	3.25
74LS188	2.25
74LS287	3.05
74LS288	2.25

ZERO INSERTION DIL SOCKETS

24pin	4.90
40pin	5.30

LOGIC ICs
including
COMPUTER
SUPPORT

ADC0800	22.50
ADC0816	14.90
ADC0817	10.06
AY5-2376	5.90
ICM7555	80p
INS1671	20.00
INS1771	20.00
INS1792	30.00
MC1466L	6.50
MC1488	55p
MC1489	55p
MC4024	3.25
MC4044	3.25
MK50250	10.00
MK50398	6.95
MM5303	6.25
MM5307	12.75
MM5357	22.50
MM57105	14.00
MM57109	12.00
MM57160	9.00
MM57161	9.00
MM58174	11.80
RO2513LC	6.99
RO2513UC	7.50
SAA5000	3.00
SAA5010	7.10
SAA5012	7.10
SAA5020	5.50
SAA5030	9.00
SAA5040	15.00
SAA5041	15.00
SAA5050	8.50
SAA5052	8.50
TMS6011	3.65
ULB2003A	85p
8T26	1.35
8T28	1.35
8T95	1.35
8T97	1.35
81LS95	90p
81LS96	1.20
81LS97	90p
81LS98	1.20
6522	3.19
6532	6.95
6821	1.12
6845	10.00
6847	10.00
6850	1.35
6852	2.40
6875	4.85
8131	3.75
8154	9.42
8155	3.50
8212	1.10
8216	1.00
8223	1.80
8224	1.10
8226	2.50
8228	2.50
8238	5.75
8243	4.68
8250	8.65
8251	3.15
8253	7.95
8254	10.00
8255	2.48
8257	4.00
8259	4.00
8279	4.40
8304	4.50
8544	1.50
8601	1.20
8678CABN	19.50
8832	2.60
8833	2.35
9097	3.00
9099	3.00
9601	5.50
9062	2.50
Z80ACTC	2.65
Z80ADART	8.00
Z80ADMA	10.00
Z80APIQ	2.80
ZN425E8	3.39
ZN426E8	3.39
ZN427E8	5.99
ZN428E8	4.05

VOLTAGE REGULATORS
(See also Linear ICs)
— Positive —

100 mA	
78L05A	30p
78L12A	30p
78L15A	30p
78L24A	30p
100 mA TO5	
78L05CH	80p
78L12CH	80p
78L15CH	80p
78L24CH	80p
500 mA TO202	
7805M	47p
7812M	47p
7815M	47p
7842M	47p
1 Amp TO220	
7805T	39p
7812T	39p
7815T	39p
7824T	39p
1.5 Amp TO03	
7805K	1.39
7812K	1.39
7815K	1.39
7824K	1.39
— Negative —	
100 mA TO92	
79L05	59p
79L12	59p
79L15	59p
500 mA TO202	
7905M	55p
7912M	55p
7915M	55p
7924M	55p
1 Amp. TO220	
7905T	44p
7912T	44p
7915T	44p
7924T	44p
1.5 Amp. TO3	
7905K	1.99
7912K	1.99
7915K	1.99
7924K	1.99
— Variable —	
L200 (2A Pos)	2.50
LM137K	12.00
LM309K	1.35
LM317K	3.42
LM317MP	95p
LM317T	1.75
LM337K	4.60
LM337MP	1.73
LM337T	1.75
LM345K	3.60
LM350K	4.50
LM396K	13.52

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High Quality
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Aluminium
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Nose £3.85
Spare Nose 75p
1,000s SOLD
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GRAPHIC PROCESSORS

EF9365	62.00
EF9366	62.00

HEATSINKS CLIP-ON

TO1 (AC128)	18p
TO5 (BFY51)	18p
TO18 (BC109)	18p
TO220 (TIP29)	36p

Many other sinks in stock including power-sinks. Please phone

Rechargeable Batteries:
Guaranteed minimum 500 charges

HP2(1.2AH)	2.10
HP2(4AH)	4.75
HP7 (½AH)	99p
HP11(1.2AH)	2.29

Chargers
TYPE H: Adjusted to 6 of any HP type Above £15.59
TYPE P: PP3 £5.50
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100KHz	2.49
200KHz	2.79
1.00MHz	2.89
1.008MHz	2.74
2.00MHz	2.24
2.097152MHz	3.50
3.2768MHz	1.50
4.00MHz	3.00
4.194394MHz	2.00
4.433619MHz	1.10
5.00MHz	1.75
6.00MHz	1.50
6.9375MHz	3.50
8.00MHz	1.75
10.00MHz	1.75
18.00MHz	1.99
20.00MHz	1.99
27.648MHz	2.60
48.00MHz	1.75
100.00MHz	5.50
5.5 MHz Ceramic filter	90p

VALVES

DY86/87/802	1.32
ECC82	1.22
ECC83	1.22
ECC84	1.22
EF86	1.80
EL34	2.89
EL84	2.50
KT66	10.75
KT88	12.50
PC900	1.76
PCC84	3.00
PCC85	3.40
PCC89	1.89
PCF86	2.30
PCF201	3.00
PCF801	2.87
PCF802	2.11
PCL82	1.80
PCL85	2.20
PCL86	2.10
PCL805	2.20
PD510	4.95
PFL200	2.99
PL504	2.11
PL508	2.36
PL509	4.75
PL802	4.17
PY88	1.82
PY500A	2.83
6L6	2.59

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UHF PL259 types
Low loss, superior quality 50Ω

Lino plug	45p
Reducer	15p
Round skt	40p
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Plug	1.10
Socket	1.00
Line skt	1.15

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Bare Wire Mains Safety Block
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4 pole 2 way
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3 amp contacts
£2.80

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Male	1.70
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2½mm Mono	12p
2½mm Metal Mono	20p
3½mm Mono	12p
3½mm Stereo	35p
3½mm Metal Mono	20p

JACK SOCKETS

Chassis	
¼" Mono	20p
¼" Stereo	25p
2½mm Mono	15p
3½mm Mono	15p
Line	
¼" Mono	20p
¼" Metal	30p
¼" Stereo	30p
¼" Stereo Metal	40p
3½mm Mono	15p
3½mm Mono Line	20p

BOOKS (no VAT)
(Post inc. prices)

Towers Transistor Manual (Bible)	10.50
TTL Data	3.95
Data conversion	4.50
Volt. Reg. Data	3.95
Interface Data	3.95
Memory applic.	4.95
Audio/Radio Hbk	4.50
Special function handbook	3.95

COAX (TV)
All Metal

Plug	26p
Socket	26p
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3½ DIGIT LCD MULTIMETER
2 amps AC DC
1KV (DC)
750V (AC)
Incredible at
£34.50
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d.c. I: 50 μA, 600 μA, 6 mA, 60 mA, 600 mA.
a.c. I: 30 mA, 300 mA, 3 A.
Ohms: 2 kΩ, 2 MΩ.
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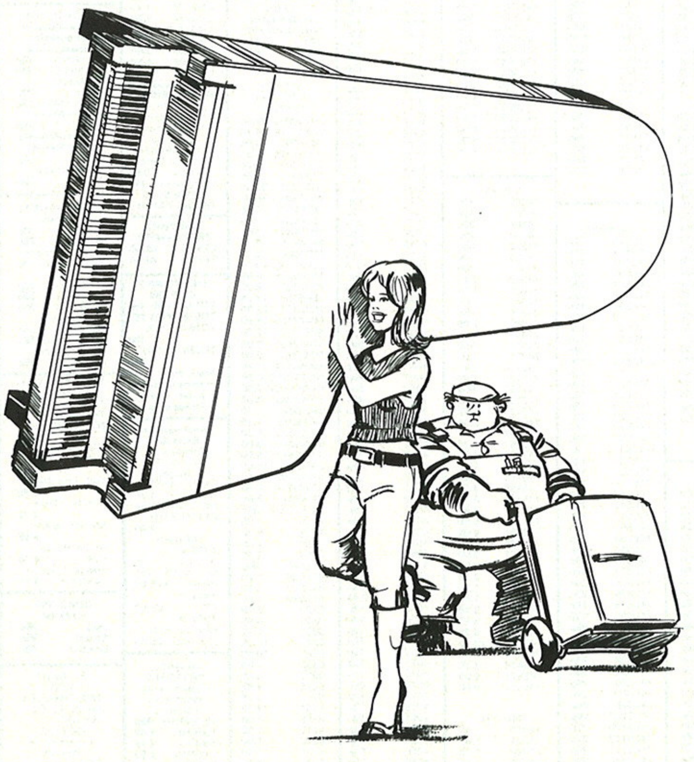

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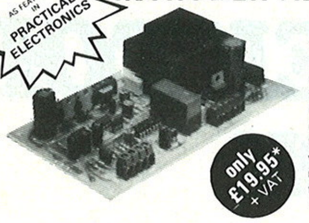
INTRUDER ALARM CONTROL UNIT
CA 1250



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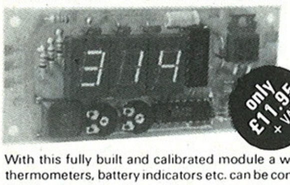
This exciting new module offers all the possible features likely to be required when building an intruder alarm system. Whether used with only 1 or 2 magnetic switches or in conjunction with several ultrasonic alarm modules or infra-red units, a really effective system can be constructed at a fraction of the cost of comparable ready-made units. Supplied with a fully explanatory Data Sheet that makes installation straight forward, the module is fully tested and guaranteed.
*available in kit form £16.95 plus VAT.

- Built-in electronic siren drives 2 loud speakers
- **Provides exit and entrance delays together with fixed alarm time**
- Battery back-up with trickle charging facility
- Operates with magnetic switches, u/sonic or I.R. units
- Anti-tamper and panic facility
- Stabilised output voltage
- 2 operating modes - full alarm/anti-tamper and panic facility
- Screw connections for ease of installation
- Separate relay contacts for switching external loads
- Test loop facility

DIGITAL VOLTMETER MODULE DVM 314

Fully built & tested



only £11.95 + VAT

- Positive & negative voltage with an FSD of 999mV which is easily extended
- Requires only single supply 7-12V
- High overall accuracy - 0.1% + 1 digit
- Large bright 0.43" LED displays
- Supplied with full applications data

With this fully built and calibrated module a wide range of accurate equipment such as multimeters, thermometers, battery indicators etc. can be constructed at a fraction of the cost of ready-made units. Full details are supplied for extending the voltage range, measuring current, resistance and temperature. Fully guaranteed, the unit has been supplied to electricity authorities, Government departments, etc.

Temperature Measurement Kit DT.10 £2.25 + VAT

Using the I.C. probe supplied, this kit provides a linear output of 10mV°C over the temperature range from 10°C to + 100°C. The unit is ideal for use in conjunction with the DVM module providing an accurate digital thermometer.

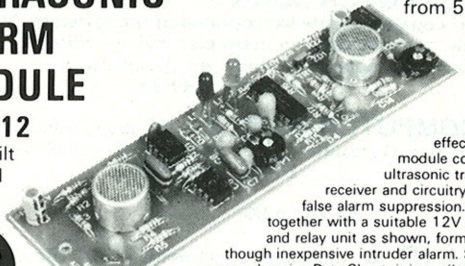
Power Supply PS.209 £4.95 + VAT

This fully built mains power supply provides two stabilised isolated outputs of 9V, 250mA each. The unit is ideally suited for operating the DVM and Temperature Measurement module.

ULTRASONIC ALARM MODULE
US 4012

Fully built
& tested

Adjustable range from 5ft. to 25ft.



only £10.95 + VAT

A really effective fully built module containing both ultrasonic transmitter and receiver and circuitry for providing false alarm suppression. This module, together with a suitable 12V power supply and relay unit as shown, forms an effective though inexpensive intruder alarm. Supplied with comprehensive Data Sheet, it is easily mounted in a wide range of enclosures. A ready-drilled case and necessary hardware is available below.

Power Supply & Relay Units PS 4012 £4.25 + VAT

Provides a stabilised 12V output and relay with 3A contacts. The unit is designed to operate one or two of the above ultrasonic units. Fully built and tested.

Siren Module SL 157 £2.95 + VAT

Produces a loud and penetrating sliding tone operating from 9-15V. Capable of driving 2 off 8 ohm speakers to SPL of 110db at 2M.
Contains an inhibit facility for use with shop lifting loops or other break to activate circuits.

Hardware Kit HW 4012 £4.25 + VAT

A suitable ready-drilled case with the various mounting pillars, mains switch socket and nuts and bolts. Designed to house the ultrasonic alarm module together with its power supply.
Size: 153mm x 120mm x 45mm.

ACCESSORIES

3-position Key Switch for use with CA 1250, supplied with 2 keys	£3.43
Magnetic switch (with magnet)	£1.17
5" Horn speaker for use with SL 157	£4.95

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60 x 45 mm
£5.95

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50 x 45 mm
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NH56A

New – 20KΩ/V AC/DC/RES/dB in 23 ranges
130 x 88 x 37mm
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YN360TR

20KΩ/V: AC/DC/R/dB/Transistor Test in 21 ranges
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DMM DD601

LCD 3½ digit (1999)
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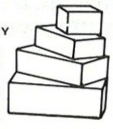

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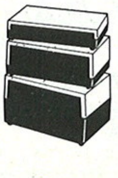

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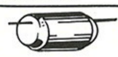

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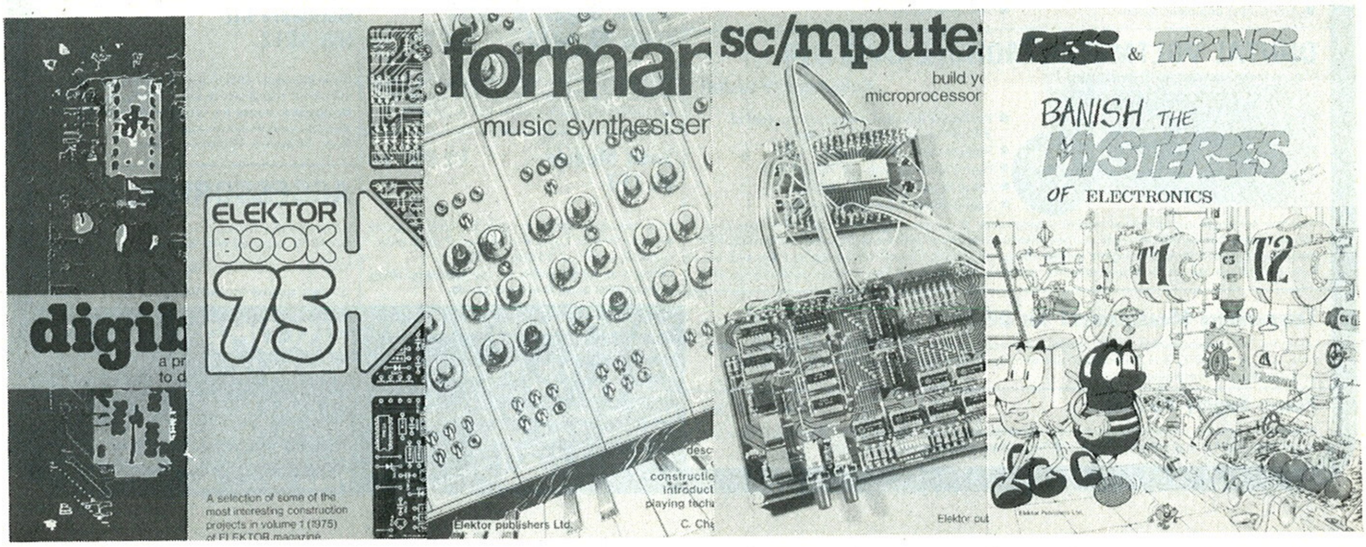
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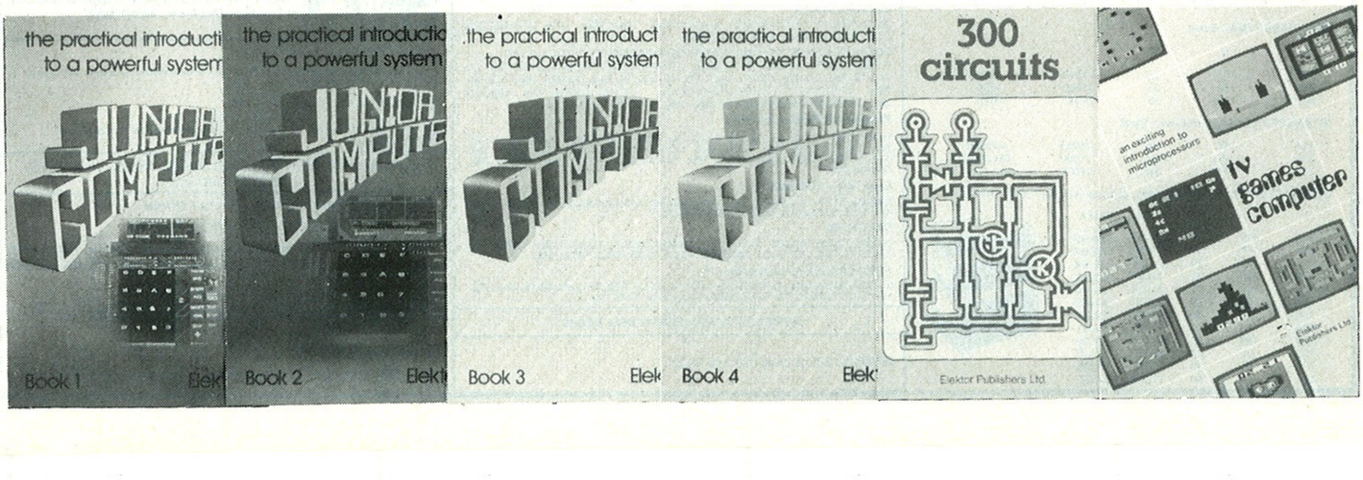

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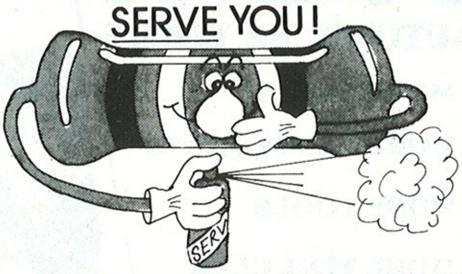

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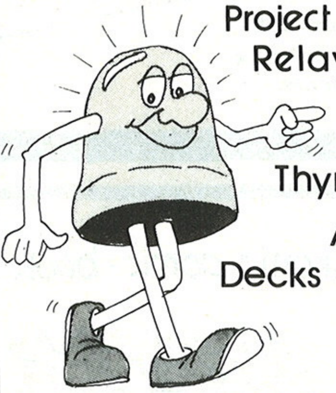

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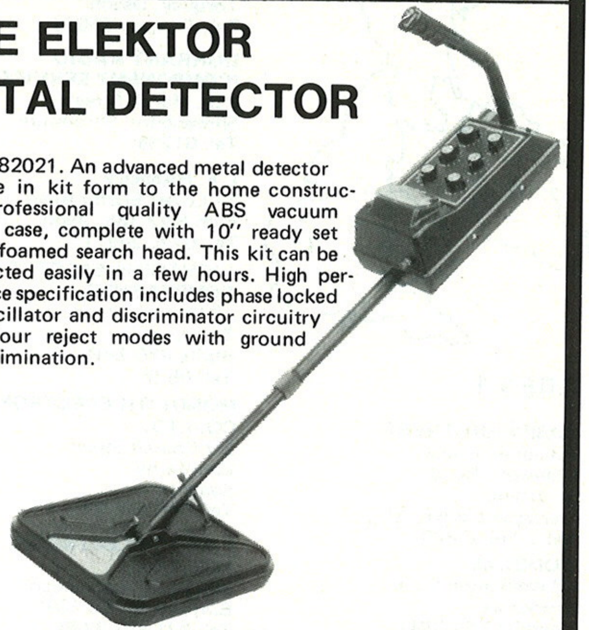

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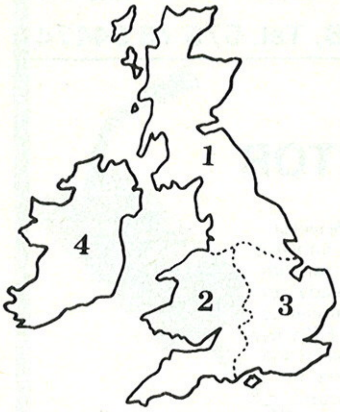

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Example:

digisplay	(E13)	9376	3.25	7.25
1	2	3	4	5

1. Circuit title
2. reference to associated article(s)
3. board number

U.K.:

4. price (in £) inclusive of 15% VAT

U.S.A. and Canada:

5. price in $, not including tax (if any)

		£	$
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formant: keyboard interface (E25)	9721-1	3.35	8.—
E29: SEPTEMBER 1977			
formant (E25, E26):			
interface receiver	9721-2	1.40	3.50
power supply	9721-3	5.50	13.—
keyboard divider (one octave)	9721-4	1.30	3.—
E31: NOVEMBER 1977			
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VCO	9723-1	9.90	23.50
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RAM-I/O	9846-1	6.90	16.50
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E32: DECEMBER 1977			
formant (E25 . . . E31):			
VCF	9724-1	4.35	10.50
experimenting with the SC/MP (E31): CPU	9851a	12.90	31.—
E33: JANUARY 1978			
simple function generator	9453	3.25	8.—
formant (E25 . . . E32):			
ADSR	9725-1	4.20	10.—
UAA 180 LED voltmeter (two boards)	9817	2.70	6.50
experimenting with the SC/MP (E31, E32):			
bus board (E57)	9857	4.—	9.50
memory card	9863	12.60	30.—
E34: FEBRUARY 1978			
formant (E25 . . . E33):			
DUAL-VCA	9726-1	4.35	10.50
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HEX-I/O	9893	18.20	43.50
E35: MARCH 1978			
formant (E25 . . . E34):			
LFO module	9727-1	4.50	11.—
noise module	9728-1	4.—	9.50
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E36: APRIL 1978			
formant (E25 . . . E35):			
COM	9729-1	4.—	9.50
elektornado	9874	3.55	8.50
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E38: JUNE 1978			
mini-counter	9927	3.15	7.50
E39/40: SUMMER CIRCUITS 1978			
touch dimmer	78065	1.30	3.—
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E41: SEPTEMBER 1978			
formant			
24 dB VCF	9953-1	4.10	10.—
E42: OCTOBER 1978			
resonance filter module	9951	4.45	10.50
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E43: NOVEMBER 1978			
ASCII keyboard	9965	7.70	18.50
E44: DECEMBER 1978			
elekterminal	9966	7.50	18.—
E48: APRIL 1979			
TV games computer:			
UHF/VHF modulator (see E42, October 1978)	9967	1.55	4.—
main board and documentation	79073	19.95	47.50
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keyboard p.c.b.	79073-2	3.65	8.50
Complete set of four boards (9967, 79073, 79073-1, 79073-2), documentation and one ESS software record (ESS 006):		26.25	62.50
E49: MAY 1979			
Interface for µPs	79101	1.40	3.50
E50: JUNE 1979			
stereo decoder	79082	2.40	5.50
E53: SEPTEMBER 1979			
parametric equaliser,			
filter section	9897-1	1.65	4.—
tone control section	9897-2	1.65	4.—
E55: NOVEMBER 1979			
topamp	80023	1.45	3.50
E56: DECEMBER 1979			
SEWAR	80009	2.85	7.—
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E57: JANUARY 1980			
digital tuning scale (two boards)	80021-1/2	7.05	17.—
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E58: FEBRUARY 1980			
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elektor vocoder,			
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bus board 2	80068-2		
filter board	80068-3	3.45	8.—
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E59: MARCH 1980			
chorosynth	80060	22.15	53.—
E60: APRIL 1980			
aide-de-camp: 12 V/2 A	7043B	1.10	2.50
transistor ignition	80084	3.90	9.50
E61: MAY 1980			
BASIC cassette interface	80050	5.60	13.50
PWM amplifier	80085	1.50	3.50
Junior computer:			
main board	80089-1	12.60	30.—
display board	80089-2	1.30	3.—
supply board	80089-3	3.—	7.—
E62: JUNE 1980			
pest pester	80130	1.10	2.50
E63/64: SUMMER CIRCUITS 1980			
STAMP amplifier	80543	1.40	3.50
PROM programmer	80556	3.85	9.—
E65: SEPTEMBER 1980			
8K RAM + EPROM card	80120	13.15	31.50
E67: NOVEMBER 1980			
central heating pump control	81019	2.55	6.—
fridge alarm	81024	1.45	3.50
E69: JANUARY 1981			
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main board	81085-2	2.45	6.—
E70: FEBRUARY 1981			
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detector board	81027-1	3.40	8.—
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E71: MARCH 1981			
MW receiver	81111	1.95	4.50
multiple sound effects generator	81112	2.05	5.—
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2 complete modules (built and tested) + 1 main board + self-adhesive front panel	81117-1	35.70	85.—
power supply	81117-2	2.05	5.—
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E72: APRIL 1981			
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E74: JUNE 1981			
Junior Computer			
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E75/76: SUMMER CIRCUITS 1981			
continuity tester	81151	1.25	3.—
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E77: SEPTEMBER 1981			
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DFM + DVM	81156	4.25	10.—
revolution counter	81171	4.90	11.50
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E78: OCTOBER 1981			
RF-test generator	81150	1.60	3.80
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EPROM programmer	81594	1.45	3.50
wide range dark room timer	82004	2.25	5.50
shutter speed meter	82005	3.75	9.—
LCD panel meter	82011	1.65	4.—
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E79: NOVEMBER 1981			
teletext			
decoder board	82001-2	5.35	12.50
keyboard section	82001-3	3.15	7.50
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metal detector	82021	5.65	13.50
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E80: DECEMBER 1981

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IPROM	82019	1.65	4.—
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E81: JANUARY 1982

EPROM programmer	82010	4.65	11.—
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frequency multiplier	82041	2.05	5.—

E82: FEBRUARY 1982

synthesiser ADSR	82032	4.20	10.—
synthesiser LFO	82033	3.90	9.50
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teletext power supply	82065	1.55	3.50
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universal NiCad charger	82070	2.05	5.—

E83: MARCH 1982

wind sound generator	82066	1.60	4.—
automatic squelch	82077	1.90	4.50
synthesiser COM	9729-1	4.—	9.50
synthesiser power supply	82078	3.70	9.—
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E84: APRIL 1982

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2114 RAM tester	82090	1.90	4.50
connection tester	82092	1.55	3.50
mini EPROM card	82093	1.65	4.50
TV sound interface	82094	1.90	4.50

E85: MAY 1982

6502 housekeeper			
main board	81170-1	4.05	9.50
display board	81170-2	3.05	7.50
elektor artist	82014	10.05	24.—
Z80-A CPU card	82105	7.05	17.—
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debounce unit	82106	2.45	6.—
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E86: JUNE 1982

the 'Poly bus'	82110	3.35	8.—
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E87/88: SUMMER CIRCUITS 1982

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5 V power supply	82570	2.20	5.—

E89: SEPTEMBER 1982

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keyboard interface	82141-2	2.—	5.—
display	82141-3	2.25	5.50
gas detector	82146	1.60	4.—
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main board	82147-1	3.—	7.—
power supply	82147-2	1.50	3.50
three phase tester	82577	2.70	6.50
TV games:			
'rapid loader'	82558-1	3.45	8.—
EPROM plug-in board	82558-2	1.95	4.50

E90: OCTOBER 1982

darkroom computer part II			
light meter	82142-1	1.75	4.—
temperature meter	82142-2	1.60	4.—
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active antenna:			
R.F. board	82144-1	1.55	3.50
power supply	82144-2	1.55	3.50
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wave shifter for SSB:			
low frequency converter	82161-1	2.05	5.—
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E91: NOVEMBER 1982

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simple function generator (E33, E38)	9453-F	2.50	6.—
Elektor Artist (E85)	82014F	1.70	4.—

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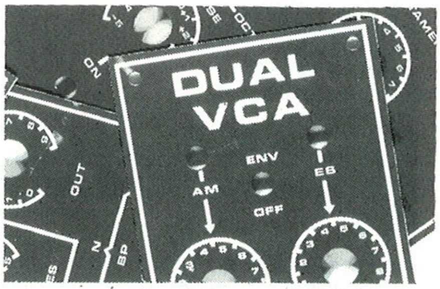

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